CCMRP

The California Report on Coronary Artery Bypass Graft Surgery

1997 – 1998 Hospital Data

Technical Report

California CABG Mortality Reporting Program

July 2001

PBGH
Pacific Business Group on Health

Planning for California's Health Care Future
OSHPD
OFFICE OF STATEWIDE HEALTH PLANNING AND DEVELOPMENT

THE CALIFORNIA CORONARY ARTERY BYPASS GRAFT MORTALITY REPORTING PROGRAM

The Pacific Business Group on Health (PBGH) and the California Office of Statewide Health Planning and Development (OSHPD) are working together in a unique private-public sector partnership to develop the California CABG Mortality Reporting Program (CCMRP). The development of CCMRP reflects the commitment of both organizations to work with health care providers to improve the quality of care statewide.

PBGH is a statewide coalition of 45 public and private sector purchasers of care in California. PBGH's member organizations represent over 3 million employees, dependents, and retirees, and they account for $3 billion in annual health care expenditures. OSHPD is the state agency that plans for and supports the development of health delivery systems to meet the current and future needs of the people of California. OSHPD conducts studies on access, cost, and quality, and is responsible for reporting risk-adjusted hospital outcomes data.

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THE CALIFORNIA REPORT ON CORONARY ARTERY BYPASS GRAFT SURGERY

1997-1998 Hospital Data

TECHNICAL REPORT

July 2001

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PREFACE

July 2001

It is with great pleasure that we share with you the first set of results from the California Coronary Artery Bypass Graft (CABG) Mortality Reporting Program (CCMRP). The ***California Report on Coronary Artery Bypass Graft Surgery: 1997-1998 Hospital Data*** is the first of a series of periodic reports on bypass surgery outcomes for California hospitals. This report is an important milestone for several reasons.

CCMRP represents an important partnership between the state, purchasers, and hospitals to voluntarily collect and release comparative quality of care data. In an environment of scarce resources, collaboration is critical. Of the 118 hospitals in California that performed bypass surgery in 1997-1998, 79 voluntarily agreed to submit their data for public reporting to CCMRP. The cases submitted by the 79 hospitals represent more than 70% of all bypass surgeries performed in California during that time period.

The participating hospitals, regardless of their individual results, are to be commended for their leadership and explicit commitment to quality measurement and improvement. Public release of comparative surgery outcomes data is helpful for hospitals in their ongoing efforts to improve clinical quality. It is also helpful for patients who have not had readily available, comparable information to help them in making informed decisions about where to receive treatment. California joins only three other states (NY, NJ, PA) with outcome data on bypass surgery.

This report is the result of the first round of an ongoing data collection effort by CCMRP. By measuring and making comparative risk-adjusted mortality rates publicly available, CCMRP aims to further the following important goals:

- Improve the quality of care and surgical outcomes for patients undergoing bypass surgery at all California hospitals;
- Stimulate a dialogue among surgeons and facilitate quality review of surgical procedures and processes of care that will lead to improved clinical outcomes;
- Increase consumer awareness and use of quality information.

The CCMRP is a unique private-public sector partnership between the Pacific Business Group on Health (PBGH) and the California Office of Statewide Health Planning and Development (OSHPD). PBGH is a California coalition of 45 public and private sector purchasers of care and its members represent over 3 million employees, dependents and retirees. OSHPD is the state agency that plans for and supports the development of California's health care delivery system and produces outcomes studies of the care being provided by California hospitals.

Again, PBGH and OSHPD commend the hospitals that have demonstrated leadership in measuring and publicly reporting on the quality of bypass surgery. We also wish to recognize the important contribution made by a host of individuals in the participating hospitals who dedicated their scarce time and resources to collecting the data and to providing feedback on

the design of the program and the risk model. Additionally, we wish to thank the CCMRP Technical Advisory Panel members, who played a critical role in helping to structure California's bypass surgery reporting program. PBGH and OSHPD also appreciate the assistance provided by the Society of Thoracic Surgeons and its California Chapter in helping to develop and implement CCMRP.

CCMRP looks forward to the participation of additional hospitals in this important quality measurement and improvement project so that all hospitals are accountable for ensuring the best possible outcomes for their patients. Hospitals that are interested in joining CCMRP are encouraged to contact Cheryl Damberg, CCMRP Co-Director at PBGH (cdamberg@ix.netcom.com, 310.396.7036).

Sincerely,

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SUMMARY

In 1995, the Pacific Business Group on Health and the California Office of Statewide Health Planning and Development entered into a private-public sector partnership to establish a statewide reporting program for coronary artery bypass graft (CABG) surgery. The program, the California CABG Mortality Reporting Program (CCMRP), is a voluntary reporting program, in contrast to the only other statewide CABG reporting programs operated by New York, New Jersey, and Pennsylvania that mandate the collection and public reporting of data.

This report presents findings from an analysis of 1997-1998 data collected from 79 of California's 118 hospitals that regularly performed CABG surgery, and focuses on the death rate while a patient remains in the hospital after undergoing bypass surgery.[1] The study includes 30,814 cases, making it the largest public reporting program on CABG outcomes in the U.S. Using pre-operative demographic and clinical characteristics of the patient, the analysis assigns a risk of mortality for each patient and uses these risks to determine an overall "case complexity" to adjust the expected performance for each hospital. Therefore, each hospital receives credit for the severity or mix of patients it treats.

This study finds that 72 out of the 79 hospitals that participated in CCMRP's reporting program performed "as expected." This means that given the complexity of cases they treated, the actual death rates at these institutions were within the range of what was expected or predicted from the risk model. Three of the 79 hospitals performed significantly better than expected (meaning their actual death rate was lower than what was expected/predicted):

- Hoag Memorial Presbyterian Hospital, serving Orange County
- Summit Medical Center, serving the San Francisco Bay Area and San Jose
- Sutter Memorial Hospital, serving Sacramento Valley and northern California.

In addition, four of the 79 hospitals performed significantly worse than expected (meaning their actual death rate was higher than what was expected/predicted):

- Downey Community Hospital, serving greater Los Angeles
- John Muir Medical Center, serving the San Francisco Bay Area and San Jose
- Mercy San Juan Hospital, serving Sacramento Valley and northern California
- Presbyterian Intercommunity Hospital, serving greater Los Angeles.

It is also important to highlight several other key findings from the analysis of the 1997-1998 CABG data submitted by California hospitals.

- Raw unadjusted mortality rates give a false impression of a hospital's relative performance, underscoring the importance of risk-adjustment when making comparisons across hospitals.

[1] If a patient is transferred post-operatively to a rehabilitation or transitional care facility and dies before going home, this death is not counted. In-hospital mortality means the patient expired prior to discharge from the hospital that performed the operation, regardless of length of stay. Deaths are not counted after discharge even if the patient dies soon after the operation and is discharged from the hospital.

- There is wide variation among California hospitals in their mortality rates for isolated coronary artery bypass graft surgery, even after adjusting for patient risk.
- The high degree of agreement between the actual and predicted number of deaths (as discussed in **Appendix F, Model Fit and Validation**) underscores that hospitals should not exclude high risk (i.e., sicker) patients from appropriate CABG surgeries in order to improve their performance scores.
- An examination of the relationship between volume of CABG procedures and outcome finds large variation in the performance results of small-volume hospitals and small variation in the performance results of large-volume hospitals (see **Section VII**).

One caveat should be noted. Because CCMRP did not have data from 38 non-participating hospitals, direct comparison of risk-adjusted mortality rates is not possible. However, an examination of OSHPD hospital discharge data shows that the aggregated raw or unadjusted mortality rates for participating hospitals are essentially identical to those of non-participating hospitals. On average, participating hospitals performed more CABG surgeries than non-participating hospitals (250 per year vs. 209 per year).

One year's results—especially among hospitals with small annual volumes of CABG surgeries—are not sufficient for drawing definitive conclusions about the performance of any given hospital. It will be important to evaluate the performance of hospitals over multiple years to determine whether there is a consistent pattern of performance, either good or bad.

PBGH and OSHPD wish to thank each of the 79 hospitals that volunteered to participate and publicly report their risk-adjusted mortality rates for the 1997-1998 data collection period. It is important to recognize that, regardless of any individual hospital's performance results, participation in CCMRP represents a significant commitment to quality measurement and improvement by each of the participating hospitals.

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The California CABG Mortality Reporting Program reflects the efforts and significant contributions of numerous individuals from PBGH and OSHPD. Dr. Arnold Milstein, PBGH Medical Director, deserves special acknowledgment for his role in helping to initiate the development of CCMRP. PBGH and OSHPD wish to thank the California Chapter of the Society for Thoracic Surgeons (CASTS) for its support and assistance in implementing CCMRP.

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GLOSSARY OF FREQUENTLY USED ACRONYMS

BMI	Body mass index
BSA	Body surface area
CABG	Coronary artery bypass graft
CASTS	California Chapter of the Society of Thoracic Surgeons
CCMRP	California Coronary Artery Bypass Graft (CABG) Mortality Reporting Program
CCS	Canadian Cardiovascular Society
CHF	Congestive heart failure
COPD	Chronic obstructive pulmonary disease
MI	Myocardial infarction
NYHA	New York Heart Association
O/E ratio	Observed to expected ratio
OSHPD	California Office of Statewide Health Planning and Development
PBGH	Pacific Business Group on Health
PTCA	Percutaneous transluminal coronary angioplasty
STS	Society of Thoracic Surgeons

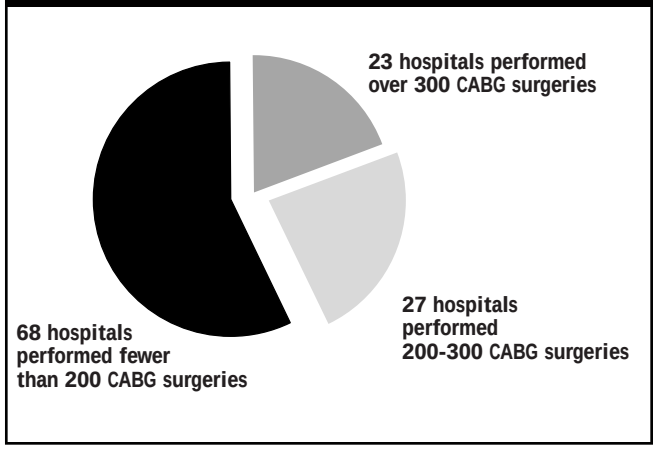
I. INTRODUCTION

The California Coronary Artery Bypass Graft Mortality Reporting Program

California Coronary Artery Bypass Graft Mortality Reporting Program (CCMRP) is a voluntary statewide hospital reporting program designed to collect and report coronary artery bypass graft (CABG) operative mortality at the hospital level. CCMRP produces uniform, hospital-level mortality data, adjusted to account for differences across hospitals in the mix of patients undergoing CABG surgery. The project was established in 1996 by the Pacific Business Group on Health (PBGH), a statewide coalition of purchasers of care, and the California Office of Statewide Health Planning and Development (OSHPD), the state agency responsible for reporting risk-adjusted hospital outcomes data. The California Chapter of the Society for Thoracic Surgeons (CASTS) and the national Society of Thoracic Surgeons (STS) also assisted with the implementation of this program.

PBGH and OSHPD selected CABG surgery because it is a frequently performed and costly procedure. Based on data from the 1998 OSHPD Patient Discharge Abstract database, 27,660 isolated[2] coronary artery bypass graft surgeries were performed at 118 California hospitals.[3] For 1998, the average hospital charge (prior to any group discounts) for a bypass procedure was approximately $78,000 (OSHPD, 1998).[4] For some hospitals, only births comprised a larger proportion of their total revenue. Among the 118 California hospitals that provided adult CABG surgery in 1998, more than half performed fewer CABG surgeries than the minimum annual volume of 200-300 cases recommended by the American College of Cardiology (1991).

Figure 1: 1998 California Hospital CABG Surgery Volumes



The Need for Comparative Outcome Data

Individuals and employers who often serve as purchasing agents for employee and dependent populations face difficulties in making informed health care purchasing and treatment decisions. Rarely is comparative information on health outcomes readily available to help guide consumer and purchaser choice in the marketplace. Consequently, purchasing and treatment decisions typically are based on price alone and not on the overall value of services—a key component of which is the quality of care.

[2] "Isolated" CABG means that no patient received both a CABG and an additional major procedure such as a valve repair or replacement during the same operation. Isolated CABG surgeries comprise the majority of heart operations in California and the U.S.

[3] All 118 hospitals performed at least 25 adult isolated CABG surgeries each during 1998.

[4] Few hospitals actually receive payment in the amount that charges represent. Reimbursement rates typically are much lower, ranging between $15,000 to $30,000 per case.

To make comparative quality information available to patients and purchasers, and to physicians and hospitals so they can engage in continuous quality improvement, PBGH and OSHPD established CCMRP. CCMRP will report, on a periodic basis, risk-adjusted mortality rates for isolated CABG surgery at each hospital in California that performs adult CABG surgery and that has voluntarily agreed to provide data to the reporting system.

In-hospital mortality was selected as a measure of hospital quality for isolated CABG surgeries because it can be reliably measured and affords comparability across hospitals. It should be noted that mortality is not the only measure of the quality of bypass surgery. Process measures and complications are also important quality indicators; however, these measures are difficult to measure reliably and in a consistent fashion across institutions to permit fair comparisons. The New York Department of Health's CABG reporting program has attempted the collection and comparison of complications data but found wide variation in reporting practices (i.e., significant under-reporting of complications) across hospitals, making uniform comparisons problematic.

Goals of CCMRP

CCMRP aims to provide comparative risk-adjusted mortality rates to:

- ***Hospitals and providers:*** to stimulate and facilitate quality review of surgical procedures and processes of care that will lead to improved outcomes;
- ***Purchasers of care:*** to assess hospital performance and incorporate quality measures into purchasing decisions; and,
- ***Patients and their family members:*** to enable them to make more informed treatment decisions.

Roadmap for this Document

Section II discusses the nature of heart disease and various treatment options, including CABG surgery. Section III describes the history and processes of the reporting program, detailing how specific data elements were selected for collection. Section IV explains how CCMRP recruited hospitals to participate in the program, Section V describes the methods CCMRP used to adjust hospital mortality data to account for risk differentials, and Section VI tabulates the resulting risk-adjusted hospital mortality rates for 1997-1998. Section VII explores the relationship between hospital volume and outcome for CABG procedures. Section VIII provides a summary of technical conclusions and Section IX describes additional resources.

Appendices provide detailed technical information. Appendix A defines the terms and instructions for CCMRP data submissions, Appendix B describes reporting programs conducted by other states and organizations, Appendix C displays the 1997-1998 CCMRP data collection form and tool, Appendix D lists the variables defined by previous research, specifically Jones and colleagues (1996), Appendix E contains the "Principles of Participation Agreement with Hospitals," Appendix F provides a technical description of the data, risk-adjustment methods, and results, and Appendix G shows univariate data summaries.

II. HEART DISEASE AND ITS TREATMENT

About Heart Disease

Heart disease is the leading cause of death among adults, both nationally and in California (American Heart Association, 1998). In 1995, 481,278 Americans died from coronary heart disease. Each year, approximately 27,000 Californians who have advanced heart disease undergo CABG surgery to help reduce pain and disability and to increase length of life.

When one of the coronary arteries is blocked or narrowed (the narrowing is called a *stenosis*), the blood supply to the heart muscle is reduced. This can lead to severe chest pain (*angina*) that can restrict a person's ability to perform normal activities or can cause a heart attack. In severe cases it can be life-threatening. Patient factors associated with a higher risk of heart disease include family history of heart disease, smoking, high blood pressure, elevated cholesterol, being overweight or obese, diabetes mellitus, and physical inactivity.

Treatment Options for Heart Disease

Treatment for patients with heart disease varies depending on the extent and severity of illness. Treatment options include:

- ***Lifestyle changes:*** including quitting smoking, improving the patient's diet to lower "bad" cholesterol (LDL) and to reduce weight, and starting a formal exercise program that improves cardiovascular fitness, thereby decreasing cardiac event rates and mortality;
- ***Medical management:*** use of aspirin, control of blood pressure, ACE inhibitors in appropriate patients, anti-anginal therapy with beta blockers and/or nitrates and/or calcium channel blockers, and cholesterol lowering medications to achieve an LDL < 100 mg/dl; and,
- ***Interventional procedures:*** such as angioplasty (Percutaneous Transluminal Coronary Angioplasty or PTCA) and CABG surgery.

The decision between these three therapies can often be difficult and should be based on the specific condition of the patient. If a patient is treated "maximally" with medications and still has symptoms, it is often necessary to proceed to either angioplasty or bypass surgery.

Angioplasty (PTCA) is a therapy commonly used to treat patients with heart disease and, in some cases, can be an alternative to coronary bypass surgery. Angioplasty is a technique in which a tiny deflated balloon is threaded through the blood vessels until it reaches the blockage. The balloon is then slightly inflated to open the blockage. When the balloon is removed, more blood can pass through the larger opening. In some cases, a thin tube (a *stent*) is inserted into the artery and left in place. Not all patients are good candidates for this procedure.

CABG surgery is the most common open-heart surgery performed today. In this surgery, a substitute blood vessel (*graft*) is attached on the surface of the heart to create a new path for

blood to bypass a blocked or diseased coronary artery. The grafts are segments of vein removed from the leg and/or an artery from the underside of the chest wall (e.g., *internal mammary artery*). The arteries bypassed are less than 1/4 inch in diameter, about the size of spaghetti. Most patients will receive more than one bypass graft. A "triple" bypass procedure means that three new paths were created to bypass three blocked coronary arteries.

In the standard bypass surgery, the breast bone is divided vertically to expose the heart, which lies just behind the bone (*sternum*). New surgical techniques also are emerging (e.g., minimally invasive approaches), where surgeons make alternative incisions that are smaller and that may, in the future, prove less painful, cosmetically more acceptable, and shorten the recovery time compared to the standard incision. This approach is still considered unproven, and the benefit of this approach over the standard approach has not been confirmed.

No surgical procedure is completely safe, but the chance of dying from bypass surgery–known as the **mortality rate**—is very low. Nationally, 2.8% of all patients who undergo CABG surgery die from complications during or after the operation (The Society of Thoracic Surgeons, 1997). Of course, a patient's overall health prior to the surgery will affect his or her chances of survival, which may be higher or lower than 2.8%. A patient's doctor can assess each individual's health condition and discuss the risks associated with the operation. Considering that this operation did not exist a generation ago, and considering how sick most bypass patients are (the severity of their disease), this is a remarkably low mortality rate.

The two kinds of physicians involved in heart care are cardiologists, who specialize in diagnosing and treating diseases of the heart, and cardiac surgeons, who perform the bypass surgery. If bypass surgery is needed, a cardiologist will refer the patient to a cardiac surgeon. For bypass surgery, important medical functions are also performed by nurses, both during surgery and afterward when the patient is recovering; the anesthesiologist (a doctor who administers anesthesia to put the patient to sleep); the perfusionist (who operates the heart-lung machine during surgery); and various other surgical assistants. The quality of care a patient receives and his or her surgical outcome depend on the performance of all of these medical professionals working together as a team.

Choosing a Treatment

Prior to making a decision to have heart surgery, patients should discuss with their doctor all the available treatment options. Each patient needs to balance the different benefits and risks associated with each option in making a treatment decision. For a substantial number of patients who undergo CABG surgery the decision to have bypass surgery is either urgent or emergent (that is, the surgery needs to be done soon after the diagnosis is made). Among the patients included in this report, about half of the cases were urgent or emergent. Consequently, patients with known heart disease should consider their options for selecting a hospital and surgical team for treatment well in advance of when they may actually need the surgery.

Scientific studies on heart surgery show that, on average, hospitals that perform a higher volume of coronary bypass procedures tend to achieve better outcomes–meaning they tend to have a lower death rate from the operation (Farley, 1992; Hannan et al., 1989; Hannan et al. 1991; Showstack et al., 1987). In 1991, the American College of Cardiology recommended that

hospitals perform a yearly minimum of 200-300 open-heart operations, the majority of which are coronary artery bypass operations (ACC, 1991). The number of bypass surgeries a hospital performs (i.e., volume of cases) is a proxy measure for quality, given that a host of research studies have shown a relationship between volume and outcome. While case volume may provide an indirect measure of performance, the volume of bypass cases alone does not provide full information about the quality of care provided at that institution.

Specifically, selecting a hospital that performs many bypass surgeries each year is not, by itself, a guarantee that a patient will achieve good results. Some hospitals do other kinds of heart surgery besides bypasses—such as heart valve repairs in combination with bypass surgery and heart transplants—that help them gain expertise in performing cardiac surgery. The research literature has shown that, on average, hospitals that perform a higher volume of open heart surgeries of all types usually develop greater expertise and achieve better surgical outcomes, as measured by lower mortality rates. It is therefore important that one consider not only the number of bypass surgeries performed by an institution but also the total number of cardiac or open-heart surgeries of all types.

Another important contributor to good surgical outcomes not captured in volume data is how well the entire team of cardiac surgeons, cardiologists, perfusionists, anesthesiologists, and nurses work together, not only during surgery but before and after. With effective teamwork, good surgical outcomes can occur at hospitals that perform few surgeries as well as at hospitals that perform many.

Given the above, studies that measure actual outcomes typically provide better information on the quality of care delivered by a hospital. Outcome measures of quality include mortality rates, complication rates, and readmission rates. Ideally, mortality rates will be risk-adjusted to account for differences in patient case-mix across different hospitals. For example, some hospitals refer more complicated cases to other hospitals with more experience in managing difficult cases. Because these patients may be more likely to die, the hospitals that receive these referrals should not be penalized for a higher mortality rate. Risk-adjustment models level the playing field between hospitals by controlling for different levels of patient health. This study presents risk-adjusted mortality rates for hospitals in California that perform bypass surgeries.

III. DESCRIPTION OF THE REPORTING PROGRAM

In designing a reporting program for California, PBGH and OSHPD worked to ensure that the program was clinically and statistically sound, and administratively feasible for hospitals to participate. PBGH and OSHPD began the formal process of implementing CCMRP in the Fall of 1996.

CCMRP Technical Advisory Panel

At the start of the project, PBGH and OSHPD assembled an advisory panel to provide guidance on the design of technical aspects of the program. During the course of the project, the technical advisory panel met periodically to discuss the outcome measure, purpose of the reporting program, selection of data elements, need for training of hospital staff and auditing of data to ensure data quality. In addition, the advisory panel reviewed and commented on the analysis plan, study findings, and the presentation of the results. The CCMRP Technical Advisory Panel is comprised of cardiac surgeons, cardiologists, and clinicians with expertise in quality of care and risk adjustment.

Review of Similar Programs

Prior to developing the structure of CCMRP, staff from PBGH and OSHPD reviewed the successes and problems experienced by the other major CABG surgical outcome reporting projects—including the New York State program, the Pennsylvania Cost Containment Council program, the Northern New England Cardiovascular Group, and the STS Cardiac Reporting Program. In addition to conducting an extensive review of the articles and documentation published by each project, staff talked with the research teams that produced the New York and Pennsylvania reports. Staff also examined the National Cardiac Surgery Database maintained by the STS and the Northern New England Program (O'Connor et al., 1991). This review revealed that most programs rely on the capture of detailed clinical information submitted directly by hospitals and physicians. Jollis and colleagues (1993) have suggested that using administrative data may result in not having the level of clinical data necessary to properly adjust for differences in pre-operative patient risk characteristics across hospitals. Appendix B describes several reporting programs operated by other states or organizations.

In structuring CCMRP, PBGH and OSHPD staff adopted a paradigm similar to the New York State Department of Health and STS programs. These systems have established a data collection system that is set up in the hospital or physician's office and focuses on capturing clinical data that identify the pre-operative condition of the patient (Hannan et al., 1994; Edwards et al., 1994). PBGH and OSHPD, with the recommendation of the CCMRP Technical Advisory Panel, decided to use data variables and definitions drawn from the STS reporting system to facilitate hospital participation.

Because the STS data collection software, risk-adjustment algorithm, and surgical results are proprietary and confidential, PBGH and OSHPD decided not to use the specific STS software and methods. An underlying tenet of CCMRP is that the risk-adjustment model will be publicly available for review and use by hospitals, researchers, and other interested individuals.

Additionally, the risk-adjusted hospital mortality rates will be made publicly available. Another difference between the approach used by the STS and CCMRP is that the STS uses a voluntary reporting system at the individual surgeon level, rather than at the hospital level.

Data Submission

To provide hospitals with flexibility and to avoid duplicating existing data collection systems, CCMRP allows participating hospitals to submit information in several different ways. For example, if a hospital or a hospital's surgeons use the STS system or their own system with compatible variable definitions (see Appendix A), the hospital can send data to CCMRP without having to re-enter their data into a separate software program. For institutions without any data collection system, CCMRP prepared a custom-written computer-based data collection instrument and provided this free-of-charge to any hospital that requested the software (Appendix C).

Selection of Data Elements

In defining the set of data elements for CCMRP, staff reviewed the clinical literature on risk predictors for bypass surgery (see Reference section for list of key articles) and examined variables collected by the leading cardiac reporting programs. In reviewing existing systems, staff listed the common variables used in each system as a means of determining whether there was consensus across existing reporting programs regarding the most important variables. A key finding of the literature review is that only a very small set of pre-operative variables accounts for most of what is explainable (in terms of a patient's pre-operative risk) for short-term CABG mortality.

Additionally, staff reviewed a consensus statement prepared by a panel of researchers from the major CABG reporting programs including the STS, the New York State Department of Health, the Northern New England Cardiovascular consortium, the Parsonnet group, and the Veterans Affairs group (Jones et al., 1996). The consensus statement examined the relative contribution of key variables collected by the various programs to adjust for differences in the severity of illness of patients across institutions. This consensus statement identified seven "core" pre-operative variables that were unequivocally related to mortality. Additionally, the Jones research team identified 13 "Level 1" variables that are likely to have a relationship and are suggested for inclusion, and 24 "Level 2" variables not clearly shown to relate directly to short-term CABG mortality, but which hold potential research or administrative interest. A list of the consensus statement variables is included in Appendix D.

Between the literature review and consensus statement, PBGH and OSHPD staff identified the universe of variables that experts were likely to be interested in, as well as an indication of the relative importance of those variables. Staff presented this information to CCMRP Technical Advisory Panel for its review, discussion, and recommendation on the final set of variables for inclusion in CCMRP. The Advisory Panel recommended collection of all "core" and "Level 1" variables, and the majority of "Level 2" variables, as identified in the review by Jones et al. Table 1 contains the list of 41 data elements collected by CCMRP. Not all data elements collected by CCMRP represent pre-operative risk factors of the patient.

Table 1: CCMRP Data Elements*

1. Date of Surgery	22. Interval (PTCA-Surgery)—(<6hrs or >6hrs)
2. Gender (STS: Sex)	23. Chronic Obstructive Pulmonary Disease (Yes/No)
3. Date of Birth	24. Congestive Heart Failure (Yes/No)
4. Race/Ethnicity (STS: Race)	25. Angina (Yes/No)
5. Insurer—Payment Source	26. Unstable Angina (Yes/No) (STS: Angina Type: Stable/Unstable)
6. Patient's Zip Code	27. NYHA CHF Class
7 Height	28. CCS Angina Class
8. Weight	29. Acuity (Elective/Urgent/Emergent/Salvage)
9. Pre-operative Creatinine (STS: Highest Serum Creatinine)	30. Ejection Fraction (%)
10. Hypertension (Yes/No)	31. Method of Measuring Ejection Fraction (LV Gram/Radionuclide/Echocardiogram)
11. Dialysis (Yes/No)	32. Left Main Stenosis (%)
12. Diabetes (Yes/No)	33. Coronary Disease—Number of Vessels (None/Single/Double/Triple)
13. Peripheral Vascular Disease (Yes/No)	34. Mitral Insufficiency (Regurgitation)
14. Cerebrovascular Disease (Yes/No)	35. Cross Clamp Time
15. Ventricular Arrhythmia (Yes/No)	36. Perfusion Time
16. Myocardial Infarction (MI) (Yes/No)	37. Internal Mammary Artery (IMA) Used (Yes/No)
17. Date/Time of Most Recent MI (STS: MI When, <6 hrs,<24hrs, 1-7 days, 7-21 days, >21 days)	38. Cardioplegia (Yes/No)
18. Number of Prior Heart Operations (Requiring Cardiopulmonary Bypass)	39. Date of Discharge
19. Date of Most Recent Cardiac Operation (STS: Previous CV Intervention: Most Recent)	40. Patient Status at Discharge
20. Number of Prior PTCA's	41. Date of Death
21. PTCA/Atherectomy on current admission (STS: During the Same Admission as Surgery)	

**Appendix A defines each data element.*

IV. HOSPITAL PARTICIPATION

Unlike some reports on hospital quality, CCMRP depends on the voluntary participation of hospitals. PBGH and OSHPD wish to thank each of the 79 hospitals that volunteered to participate and publicly report their risk-adjusted mortality rates. It is critical to recognize that, regardless of any individual hospital's performance results, participation in CCMRP represents a significant commitment to quality measurement and improvement by each of the participating hospitals. The results and conclusions contained in this report can be used to compare hospitals that voluntarily chose to participate, but not those hospitals that elected not to participate. This section describes how every hospital was afforded the opportunity to participate.

CCMRP approached every California hospital that performed more than 25 adult CABG surgeries annually with an offer to join CCMRP.[5] Letters of invitation to participate were sent to the Chief Executive Officer and Chief of Cardiothoracic Surgery at each institution. Staff made follow-up phone calls to encourage participation and offered to come on-site and brief hospital staff about the program. One-on-one meetings were held with interested hospitals to inform them of the program's purpose, structure, requirements of participation, and to address questions. As part of the recruitment process, all hospitals received multiple mailings and phone calls to enlist interest and participation between Fall 1996 and March 1999. PBGH and OSHPD sent a final invitation letter by certified mail to the CEOs of non-participating hospitals to enlist their participation in the 1997-1998 data collection effort. The letter provided a deadline for joining the program for this report and indicated that hospitals that declined to participate would be listed as such in the public report.

Hospitals that elected to participate were asked to sign a "Principles of Participation" agreement (Appendix E) that formally committed them to:

- Report pre-operative risk factors and mortality data for all isolated CABG surgeries performed during the calendar year (a hospital was not permitted to participate if it chose to submit only a portion of its caseload);
- Participate in a training session designed to improve consistency in coding practices across hospitals;
- Submit data on a quarterly basis using a standard data entry format and standard variable definitions;
- Participate in periodic audits to verify data quality; and,
- Publicly release their risk-adjusted mortality rates.

Table 2 lists the 118 hospitals in California that performed more than 25 adult isolated CABG surgeries in 1998 and their participation status in CCMRP. Hospitals that participate in CCMRP have agreed to make their institution's risk-adjusted mortality rates publicly available. This willingness to engage in CCMRP public reporting effort demonstrates a hospital's commitment to quality assessment and improvement.

[5] In 1998, 118 out of 121 California hospitals met this threshold for inclusion.

Table 2 shows, for each institution for 1998:[6]

- The hospital's participation status in the 1997-1998 data reporting period;
- The region in which the hospital is located;
- The total number of open-heart procedures performed;
- The total number of isolated CABG surgeries; and,
- The percentage of all open-heart procedures that isolated CABG surgeries represent at that institution.

[6] UC San Diego University Medical Center comprises two hospital facilities (Thornton and Hillcrest)

Table 2: California Hospitals that Perform Adult CABG Surgeries—1998

Hospital	CCMRP Participation Status in 1997/98 Program	Region	Number of Open-heart Procedures*	Number of Isolated CABG Surgeries*	Isolated CABG as a % of all Open-heart Procedures
Alta Bates Medical Center	Participating	San Francisco Bay Area and San Jose	172	120	69.8
Alvarado Hospital Medical Center	Participating	Greater San Diego	221	162	73.3
Anaheim Memorial Hospital	Participating	Orange County	156	125	80.1
Antelope Valley Hospital Medical Center	Declined to Participate	San Fernando Valley, Antelope Valley, Ventura and Santa Barbara	54	48	88.9
Bakersfield Memorial Hospital	Declined to Participate	Central California	417	315	75.5
Beverly Hospital	Declined to Participate	Greater Los Angeles	37	32	86.5
Brotman Medical Center	Declined to Participate	Greater Los Angeles	73	62	84.9
California Pacific Medical Center	Participating	San Francisco Bay Area and San Jose	279	178	63.8
Cedars-Sinai Medical Center	Participating	Greater Los Angeles	717	412	57.5
Centinela Hospital Medical Center	Declined to Participate	Greater Los Angeles	97	66	68.0
Community Memorial Hospital—San Buenaventura	Participating	San Fernando Valley, Antelope Valley, Ventura and Santa Barbara	240	192	80.0
Dameron Hospital	Participating	Central California	124	105	84.7
Daniel Freeman Memorial Hospital	Participating	Greater Los Angeles	220	160	72.7
Desert Regional Medical Center	Participating	Inland Empire, Riverside and San Bernardino	146	120	82.2
Doctor's Hospital—San Pablo	Participating	San Francisco Bay Area and San Jose	109	93	85.3
Doctors Medical Center—Modesto	Participating	Central California	576	457	79.3
Dominican Santa Cruz Hospital	Participating	San Francisco Bay Area and San Jose	181	134	74.0
Downey Community Hospital	Participating	Greater Los Angeles	145	116	80.0
Eisenhower Medical Center	Declined to Participate	Inland Empire, Riverside and San Bernardino	185	147	79.5
El Camino Hospital	Participating	San Francisco Bay Area and San Jose	156	110	70.5
Encino-Tarzana Regional Medical Center	Participating	San Fernando Valley, Antelope Valley, Ventura and Santa Barbara	260	183	70.4
Enloe Medical Center	Declined to Participate	Sacramento Valley and Northern California	313	273	87.2

Table 2: California Hospitals that Perform Adult CABG Surgeries—1998 (cont.)

Hospital	CCMRP Participation Status in 1997/98 Program	Region	Number of Open-heart Procedures*	Number of Isolated CABG Surgeries*	Isolated CABG as a % of all Open-heart Procedures
Fountain Valley Regional Hospital and Medical Center—Euclid	Declined to Participate	Orange County	200	174	87.0
French Hospital Medical Center	Declined to Participate	San Fernando Valley, Antelope Valley, Ventura and Santa Barbara	309	257	83.2
Fresno Community Hospital and Medical Center	Declined to Participate	Central California	420	330	78.6
Garfield Medical Center	Declined to Participate	Greater Los Angeles	120	102	85.0
Glendale Adventist Medical Center—Wilson Terrace	Participating	San Fernando Valley, Antelope Valley, Ventura and Santa Barbara	247	206	83.4
Glendale Memorial Hospital and Health Center	Participating	San Fernando Valley, Antelope Valley, Ventura and Santa Barbara	236	192	81.4
Good Samaritan Hospital—Los Angeles	Declined to Participate	Greater Los Angeles	1019	733	71.9
Good Samaritan Hospital of Santa Clara Valley/San Jose (Columbia)	Declined to Participate	Greater San Francisco Bay Area and San Jose	518	398	76.8
Granada Hills Community Hospital	Participating	San Fernando Valley, Antelope Valley, Ventura and Santa Barbara	84	75	89.3
Green Hospital of Scripps Clinic	Declined to Participate	Greater San Diego	272	181	66.5
Heart Hospital of the Desert	Participating	Inland Empire, Riverside and San Bernardino	162	117	72.2
Hoag Memorial Hospital Presbyterian	Participating	Orange County	369	269	72.9
Huntington Memorial Hospital	Declined to Participate	Greater Los Angeles	502	377	75.1
Inter-Community Medical Center—Citrus Valley	Participating	Greater Los Angeles	277	225	81.2
John Muir Medical Center	Participating	San Francisco Bay Area and San Jose	178	124	69.7
Kaiser Foundation Hospital—Los Angeles (Sunset)	Participating	Greater Los Angeles	1685	1267	75.2
Kaiser Foundation Hospital—San Francisco (Geary)	Participating	San Francisco Bay Area and San Jose	1430	992	69.4

Table 2: California Hospitals that Perform Adult CABG Surgeries—1998 (cont.)

Hospital	CCMRP Participation Status in 1997/98 Program	Region	Number of Open-heart Procedures*	Number of Isolated CABG Surgeries*	Isolated CABG as a % of all Open-heart Procedures
Kaweah Delta District Hospital	Participating	Central California	367	295	80.4
Lakewood Regional Medical Center	Declined to Participate	Greater Los Angeles	273	236	86.4
Lancaster Community Hospital	Participating	San Fernando Valley, Antelope Valley, Ventura and Santa Barbara	50	47	94.0
Little Company of Mary Hospital	Participating	Greater Los Angeles	240	165	68.8
Loma Linda University Medical Center	Declined to Participate	Inland Empire, Riverside and San Bernardino	824	471	57.2
Long Beach Community Hospital	Declined to Participate	Greater Los Angeles	140	116	82.9
Long Beach Memorial Medical Center	Participating	Greater Los Angeles	495	370	74.7
Los Angeles County—USC Med Ctr	Participating	Greater Los Angeles	227	117	51.5
Los Angeles County Harbor—UCLA	Declined to Participate	Greater Los Angeles	252	156	61.9
Los Robles Regional Medical Center	Declined to Participate	San Fernando Valley, Antelope Valley, Ventura and Santa Barbara	345	270	78.3
Marian Medical Center	Declined to Participate	Central California	117	100	85.5
Marin General Hospital	Participating	San Francisco Bay Area and San Jose	115	87	75.7
Memorial Medical Center—Modesto	Participating	Central California	326	276	84.7
Mercy General Hospital	Participating	Sacramento Valley and Northern California	1714	1269	74.0
Mercy Medical Center—Redding	Participating	Sacramento Valley and Northern California	300	226	75.3
Mercy San Juan Hospital	Participating	Sacramento Valley and Northern California	246	185	75.2
Methodist Hospital of Southern California	Participating	Greater Los Angeles	277	210	75.8
Mills Peninsula Medical Center	Participating	San Francisco Bay Area and San Jose	219	162	74.0
Mission Hospital Regional Medical Center	Declined to Participate	Orange County	297	233	78.5
Mt. Diablo Medical Center	Participating	San Francisco Bay Area and San Jose	683	544	79.6
Northridge Hospital Medical Center	Participating	San Fernando Valley, Antelope Valley, Ventura and Santa Barbara	173	131	75.7

Table 2: California Hospitals that Perform Adult CABG Surgeries—1998 (cont.)

Hospital	CCMRP Participation Status in 1997/98 Program	Region	Number of Open-heart Procedures*	Number of Isolated CABG Surgeries*	Isolated CABG as a % of all Open-heart Procedures
O'Connor Hospital—San Jose	Declined to Participate	San Francisco Bay Area and San Jose	215	161	74.9
Palomar Medical Center	Participating	Greater San Diego	188	146	77.7
Pomona Valley Hospital Medical Center	Participating	Inland Empire, Riverside and San Bernardino	311	268	86.2
Presbyterian Intercommunity Hospital	Participating	Greater Los Angeles	151	113	74.8
Providence Holy Cross Medical Center	Participating	San Fernando Valley, Antelope Valley, Ventura and Santa Barbara	107	78	72.9
Providence St. Joseph Medical Center	Participating	San Fernando Valley, Antelope Valley, Ventura and Santa Barbara	309	202	65.4
Queen of the Valley Hospital—Napa	Declined to Participate	San Francisco Bay Area and San Jose	157	123	78.3
Redding Medical Center	Participating	Sacramento Valley and Northern California	673	496	73.7
Riverside Community Hospital	Participating	Inland Empire, Riverside and San Bernardino	473	364	77.0
Saddleback Memorial Medical Center	Participating	Orange County	220	173	78.6
Salinas Valley Memorial Hospital	Participating	San Francisco Bay Area and San Jose	370	314	84.9
San Antonio Community Hospital	Participating	Inland Empire, Riverside and San Bernardino	170	143	84.1
San Joaquin Community Hospital	Declined to Participate	Central California	370	291	78.6
San Jose Medical Center (Columbia)	Declined to Participate	Greater San Francisco Bay Area and San Jose	115	89	77.4
Santa Barbara Cottage Hospital	Participating	San Fernando Valley, Antelope Valley, Ventura and Santa Barbara	372	266	71.5
Santa Clara Valley Medical Center	Declined to Participate	San Francisco Bay Area and San Jose	98	65	66.3
Santa Monica—UCLA Medical Center	Participating	Greater Los Angeles	66	44	66.7
Santa Rosa Memorial Hospital	Declined to Participate	San Francisco Bay Area and San Jose	345	245	71.0
Scripps Memorial Hospital—La Jolla	Participating	Greater San Diego	601	339	56.4
Scripps Mercy Hospital and Medical Center	Declined to Participate	Greater San Diego	302	222	73.5
Sequoia Hospital	Participating	San Francisco Bay Area and San Jose	516	250	48.4
Seton Medical Center	Participating	San Francisco Bay Area and San Jose	673	558	82.9
Sharp Chula Vista Medical Center	Participating	Greater San Diego	328	260	79.3
Sharp Grossmont Hospital	Participating	Greater San Diego	190	133	70.0

Table 2: California Hospitals that Perform Adult CABG Surgeries—1998 (cont.)

Hospital	CCMRP Participation Status in 1997/98 Program	Region	Number of Open-heart Procedures*	Number of Isolated CABG Surgeries*	Isolated CABG as a % of all Open-heart Procedures
Sharp Memorial Hospital	Participating	Greater San Diego	474	314	66.2
St. Agnes Medical Center	Declined to Participate	Central California	519	388	74.8
St. Bernadine Medical Center	Participating	Inland Empire, Riverside and San Bernardino	697	565	81.1
St. Francis Medical Center	Participating	Greater Los Angeles	108	89	82.4
St. Helena Hospital	Participating	San Francisco Bay Area and San Jose	287	250	87.1
St. John's Hospital and Health Center	Participating	Greater Los Angeles	200	141	70.5
St. John's Regional Medical Center	Participating	San Fernando Valley, Antelope Valley, Ventura and Santa Barbara	262	198	75.6
St. Joseph Hospital—Orange	Participating	Orange County	381	292	76.6
St. Joseph's Medical Center—Stockton	Participating	Central California	357	282	79.0
St. Jude Medical Center	Participating	Orange County	270	197	73.0
St. Mary Medical Center—Long Beach	Participating	Greater Los Angeles	101	79	78.2
St. Mary Regional Medical Center—Apple Valley	Declined to Participate	Inland Empire, Riverside and San Bernardino	131	117	89.3
St. Mary's Medical Center—San Francisco	Declined to Participate	San Francisco Bay Area and San Jose	972	831	85.5
St. Vincent Medical Center	Participating	Greater Los Angeles	359	229	63.8
Stanford University Hospital	Participating	San Francisco Bay Area and San Jose	567	275	48.5
Summit Medical Center	Participating	San Francisco Bay Area and San Jose	232	153	65.9
Sutter Memorial Hospital	Participating	Sacramento Valley and Northern California	1080	707	65.5
Torrance Memorial Medical Center	Participating	Greater Los Angeles	300	201	67.0
Tri-City Medical Center	Participating	Greater San Diego	278	226	81.3
UC San Diego University Medical Center (Thornton and Hillcrest)	Participating (both hospitals)	Greater San Diego	189	49	25.9
UCLA Medical Center	Participating	Greater Los Angeles	571	180	31.5
UCSF Medical Center	Participating	San Francisco Bay Area and San Jose	507	138	27.2
UCSF/Mount Zion	Participating	San Francisco Bay Area and San Jose	56	42	75.0

Table 2: California Hospitals that Perform Adult CABG Surgeries—1998 (cont.)

Hospital	CCMRP Participation Status in 1997/98 Program	Region	Number of Open-heart Procedures*	Number of Isolated CABG Surgeries*	Isolated CABG as a % of all Open-heart Procedures
University of California Davis Medical Center	Participating	Sacramento Valley and Northern California	207	136	65.7
University of California Irvine Medical Center	Participating	Orange County	138	95	68.8
USC University Hospital	Participating	Greater Los Angeles	182	72	39.6
Valley Presbyterian Hospital	Declined to Participate	San Fernando Valley, Antelope Valley, Ventura and Santa Barbara	86	72	83.7
Washington Hospital—Fremont	Participating	San Francisco Bay Area and San Jose	217	166	76.5
West Anaheim Medical Center	Declined to Participate	Orange County	67	62	92.5
West Hills Regional Medical Center	Declined to Participate	San Fernando Valley, Antelope Valley, Ventura and Santa Barbara	113	82	72.6
Western Medical Center—Santa Ana	Declined to Participate	Orange County	159	124	78.0
Western Medical Center Hospital—Anaheim	Declined to Participate	Orange County	200	164	82.0
White Memorial Medical Center	Declined to Participate	Greater Los Angeles	112	90	80.4

**Source: Office of Statewide Health Planning and Development (OSHPD) Patient Discharge database. Excludes three Veterans Administration Hospitals in Los Angeles, San Diego, and San Francisco that also perform CABG surgeries. For this table, counts of surgical procedures are calculated from the patient's date of discharge from a hospital (that is, a patient receiving a CABG surgery on December 30, 1997 who was discharged on January 3, 1998 is counted among 1998 discharges).*

For the 1997-1998 Reporting period, 79 of the 118 hospitals that regularly performed CABG surgery in 1998 voluntarily submitted data to CCMRP for public reporting of their risk-adjusted hospital mortality rates. Among hospitals that elected not to join the program, hospital staff gave a range of reasons for not participating, including a lack of sufficient staff resources to collect data, discomfort with publicly releasing data, and concern about the adequacy of the risk-adjustment method to fairly account for the sickness level of the patients they treat.

Because hospitals that chose not to participate did not submit data to CCMRP, a direct comparison of their risk-adjusted rates is not possible. However, based on OSHPD hospital discharge abstracts for the year 1998, the 79 participating hospitals performed a total of 19,714 isolated CABG surgeries, while the 38 non-participating hospitals performed a total of 7,946 cases. Table 3 provides a comparison of the number of isolated CABG surgeries and the "raw" or unadjusted death rate for participating and non-participating hospitals.

Table 3: Comparison of Unadjusted Mortality Rates for CCMRP Participating and Non–Participating Hospitals, 1998 Data

	Number of Isolated CABG's	Share of All California CABG Cases (%)	In–hospital Deaths After CABG	Unadjusted Death Rate (%)
Participating Hospitals (79)[7]	19,714	71.3	522	2.65
Non–Participating Hospitals (38)	7,946	28.7	213	2.68
Total (118)	27,660	100.0	735	2.66

On average, participating hospitals performed more CABG surgeries than non-participants (approximately 250 per year for participants vs. 209 per year for non-participants), but the unadjusted death rate for the two groups is essentially identical. Participating hospitals performed 71% of isolated CABG surgeries in California in 1998.

[7] For the 1997-1998 data reporting period, 80 out of a total of 118 California hospitals participated in CCMRP, However, CCMRP reports risk-adjusted mortality rates only for 79 hospital reporting units because UC San Diego University Medical Center, which represents two hospital facilities (Thornton and Hillcrest), submitted combined data for 1997-1998.

V. METHODS USED TO RISK-ADJUST HOSPITAL MORTALITY DATA

Patients at different hospitals may vary in the severity of their pre-operative clinical condition. To make a fair comparison across hospitals, it is therefore necessary to adjust for differences in the risk-level of each hospital's patients. CCMRP "levels the playing field" by accounting for the pre-operative condition of each patient at the time he or she is admitted to the hospital. Hospitals that routinely handle "tougher" cases get a larger risk-adjustment factor, while hospitals that handle "easier" cases get a smaller factor. Note that CCMRP intends to include as risk-adjustment variables only those data elements that describe the patient's condition as closely as possible to the time of hospital admission. The goal is to produce a statistical model that can be used to risk-adjust hospital outcomes by removing patient factors existing prior to the hospitalization that can affect survivorship.

The text below summarizes the methods used to risk-adjust hospital mortality data. Readers interested in a more thorough explanation of the data, risk-adjustment methods, and results should refer to Appendix F.

Data

The risk analysis is based on 30,814 isolated CABG cases for 82 California hospitals that submitted data to CCMRP for 1997 and 1998. Data for these 82 hospitals represent more than 70% of the isolated CABG cases performed in California.[8] CCMRP collected a set of 41 data elements for each patient who underwent an isolated CABG procedure at the participating hospitals. The data elements (listed in Table 1) focus on demographic characteristics and the pre-operative condition—also known as risk factors of the patient. The outcome measure utilized was **in-hospital mortality** (i.e., the deaths that occurred in the same hospital admission).

CCMRP evaluated the data submitted from each hospital for completeness and potential data errors. When problems were identified, CCMRP contacted hospital staff to encourage investigation of potential data errors, and, when necessary, to request replacement of incomplete or erroneous data. When data were missing from the hospital submission, CCMRP replaced the blank field with the lowest risk-category for the variable that was missing. For example, if the hospital left the field *diabetes* (yes or no) unmarked, CCMRP presumed the condition was not present for that patient and assigned a "no" to that field. Likewise, if the field for *NYHA congestive heart failure class* was unmarked, we assigned the lowest risk category to this record—in this case, NYHA Class I. The CCMRP policy decision to assign the lowest risk category to any missing data element was based on three factors: 1) many hospitals may leave data fields blank by design (e.g., blank means a comorbid condition was not present or was a STS coding convention such as for creatinine <2.0); 2) consistency with the other major cardiac reporting programs, which recode missing data with the lowest or normal value; and 3) declining to give hospitals any additional credit in the risk model when coding is incomplete, thereby creating an incentive for more complete coding.

[8] Three of the 82 Hospitals that submitted data for the 1997-1998 period withdrew from the program after the analysis was completed but prior to preparation of the report, leaving 79 hospitals that agreed to publicity report their results. However, data from all 82 hospitals was used to develop the risk-adjustment model.

After preliminary data cleaning and analyses were completed, CCMRP developed and implemented an audit process designed to review the quality of the data submitted for 1998. The intent of the audit was to determine whether the rating received by the hospital was in any way a function of that hospital's coding practices. That is, did hospitals classified as better performers systematically overstate the severity of their cases, or did hospitals classified as worse performers systematically understate the severity of their patient case-mix? Twenty-six hospitals were audited out of the 79 that are publicly reporting for the first round of data collection, or 33% of the hospitals reporting. CCMRP concluded from the audit analysis that there was no relationship between a hospital's average patient risk-level and the rating received by the hospital.

Risk Model

CCMRP used a multivariate logistic regression model to determine the relationship between each of the demographic and pre-operative risk variables and the likelihood of in-hospital mortality. Multivariate logistic regression models relate the probability of death to the explanatory factor, (e.g., patient age, the amount of creatinine in the blood, or the anginal status of the patient) while controlling for all other explanatory factors in the model. For example, the odds ratio of 1.05 for age derived in CCMRP model means that a patient one year older than another will have an odds of dying 1.05 times higher—when all other factors are held constant. Table 4 presents the final model based on the 1997-1998 CCMRP data set.

Table 4: CCMRP 1997–1998 Logistic Regression Model

Explanatory Factor	Coefficient	Std. Error	t–value	Odds Ratio	Missing Variable Assignment
(Intercept)	–7.206	0.411	–17.512		
Age (in years)	0.044	0.004	**10.812**	1.05	Case Excluded
Sex					
Female	Reference				
Male	–0.401	0.080	**–5.005**	0.67	Male
Race					
White	Reference				White
Non–white	0.203	0.088	**2.294**	1.23	
Creatinine (mg/dl)	0.214	0.039	**5.433**	1.24	1.0; Truncated at 10
Hypertension	0.075	0.087	0.866	1.08	No
Dialysis	–0.029	0.275	–0.105	0.97	No
Diabetes	0.142	0.080	1.776	1.15	No
Peripheral Vascular Disease	0.435	0.091	**4.800**	1.54	No
Cerebrovascular Disease	0.244	0.101	**2.410**	1.28	No
Ventricular Arrhythmia	0.337	0.123	**2.737**	1.40	No
COPD	0.275	0.094	**2.914**	1.32	No
Operative Incidence					
First	Reference				First Operation
Second	0.674	0.118	**5.733**	1.96	
Third	1.354	0.276	**4.901**	3.87	
Fourth or Higher	1.823	0.660	**2.763**	6.19	
Myocardial Infarction					
None	Reference				None
Yes, but When Unknown	0.156	0.196	0.797	1.17	
21+ Days ago	0.028	0.105	0.263	1.03	
7–20 Days ago	–0.227	0.198	–1.145	0.80	
1–6 Days ago	0.237	0.107	**2.211**	1.27	
Within 1 day	0.876	0.150	**5.831**	2.40	
PTCA on This Admission	0.220	0.156	1.411	1.25	No
Angina					
None	Reference				
Stable	–0.369	0.137	**–2.691**	0.69	Angina Stable
Unstable	–0.256	0.129	**–1.977**	0.77	
NYHA CHF Class					
I	Reference				
II	0.506	0.122	**4.141**	1.66	NYHA Class I
III	0.549	0.109	**5.037**	1.73	
IV	0.769	0.102	**7.530**	2.16	
CCS Angina Class					
I	Reference				
II	0.178	0.192	0.927	1.19	
III	0.070	0.173	0.404	1.07	CCS Class III
IV	0.211	0.175	1.203	1.23	

Table 4: CCMRP 1997–1998 Logistic Regression Model (cont.)

Explanatory Factor	Coefficient	Std. Error	t–value	Odds Ratio	Missing Variable Assignment
Acuity					
Elective	Reference				Elective
Urgent	0.221	0.090	**2.449**	1.25	
Emergent	0.743	0.136	**5.482**	2.10	
Salvage	2.806	0.218	**12.860**	16.55	
Ejection Fraction (%)	–0.012	0.003	**–4.393**	0.99	55; Truncated at 15.0
Left Main Stenosis					
0–50%	Reference				0–50%
51–70%	–0.015	0.126	–0.117	0.99	
71–90%	0.233	0.130	1.786	1.26	
91+%	0.525	0.153	**3.426**	1.69	
Type of Coronary Disease					
Single Vessel	Reference				Single Vessel Disease
Double vessel	–0.176	0.181	–0.974	0.84	
Triple or More	0.069	0.160	0.433	1.07	
LM Only disease	0.447	0.359	1.244	1.56	
Mitral Regurgitation					
None	Reference				None
Trivial	0.506	0.158	**3.203**	1.66	
Mild	0.247	0.151	1.638	1.28	
Moderate	0.612	0.192	**3.187**	1.84	
Severe	0.898	0.345	**2.598**	2.45	

Age, ejection fraction, and creatinine were entered as continuous variables; the other variables were entered as ordered factors. For the variables entered as ordered factors, the coefficients should be compared to the reference category (for example, we show coefficients for NYHA Classes II, III, and IV; those coefficients are compared to the reference category of NYHA Class I). Bolded t–values indicate the coefficient for that variable is statistically significant at the 0.05 level.

GUIDE TO INTERPRETING THE RISK MODEL

Coefficient: The coefficient of the explanatory factor indicates the effect of a patient having the characteristic on the likelihood of in-hospital death following bypass surgery. If the value is positive, it means that the characteristic is associated with an increased risk of death compared to not having the characteristic—while controlling for the effect of all of the other factors. If the coefficient is negative, having that characteristic is associated with a lower risk of death compared to not having it. The larger the value (whether positive or negative), the greater the effect or weight this characteristic has on the risk of dying. For example, note that the coefficient for *peripheral vascular disease (PVD)* is 0.435 and significant. This value is positive, so it indicates that CABG patients with *peripheral vascular disease* are at an increased risk of dying in the hospital compared to patients that do not have the disease. On the other hand, the coefficient for the variable *male* has a value of –0.401. Since the value is negative, it means that males have a lower probability of dying in the hospital than females—after taking into account all other factors.

Standard Error: The standard error is the standard deviation of the sampling distribution of an estimate, and is a measurement of the statistical reliability of that estimate. The coefficient divided by the standard error produces the t-statistic.

t–Value: The t-value is a measure of the statistical significance of the coefficient. When the t-value is large (whether positive or negative), it means that we are relatively confident that the effect of the factor is real. If the t–value is small, we are less confident that the effect was not observed by chance alone. A common rule of thumb for interpreting this column is that if the absolute t-value is larger than 2.0, we have some confidence that the effect of the factor is real. For example, the t-value for the male explanatory factor is -5.005. Since it's absolute value is greater than 2.0, we have some confidence that the sex of the patient is a statistically significant factor in explaining in–hospital mortality for CABG patients. **Not all of the explanatory factors in our model have t-values that are larger than 2.0.** For example, the t–values for CCS angina class and type of coronary artery disease (single vessel disease, double, triple, or left main only disease) are all quite small. This indicates that, for our data, neither coronary disease type nor CCS class are reliable predictors of in-hospital mortality. Note that a small t–value does not mean that factor has no effect on in-hospital mortality—it means that the effect, if any, is not reliably estimated.

Odds Ratio: Another way of assessing the impact of each factor on in–hospital mortality is to utilize the odds ratio. Mathematically, the odds ratio is simply the antilogarithm of the coefficient value, but it is often easier to interpret. The larger the odds ratio, the greater the impact that characteristic has on the risk of dying. An odds ratio close to 1.0 means that the effect of the factor is close to neutral. For example, the odds ratio for *peripheral vascular disease* (PVD) is

1.54. This means that if the patient has *peripheral vascular disease* the odds of dying in–hospital are about 1.54 times higher than if the patient did not have PVD. Being *male* has an odds ratio of 0.67, which means that the odds that a man will die in–hospital after CABG surgery is about 0.67 times as high (i.e., about two thirds as much) as for a woman.

Missing Data Assignment: When data were missing from the hospital submission, CCMRP replaced the blank fields with the lowest risk category for the variable that was missing. For example, if the hospital left the field for *NYHA congestive heart failure class* unmarked, we assigned the lowest risk category to this record—in this case, NYHA Class I. This column indicates the specific category used to replace missing data for each variable.

Key Technical Findings Regarding the Risk Model

- Although several of the variables do not appear to be "statistically significant" (as determined by the t–value), almost all coefficients appear with the expected sign from a clinical standpoint.
- Age, acuity (i.e., how urgent the operation was), ejection fraction, and operative incidence are very important risk–model variables.
- Even after controlling for all other variables, sex appears to have a statistically significant effect, with males having about one–third lower mortality. The literature suggests that sex may serve as a proxy for body size; unfortunately, although the CCMRP attempted to collect height and weight to construct an index of body mass, the analysis was hampered by missing values and the apparent confusion of metric (kilogram and centimeter) and English (pound and inch) units in the data submission.
- After accounting for creatinine levels, dialysis appears to have no additional explanatory power. That is, given that a dialysis patient has higher creatinine levels than the average patient, once one knows that level, the fact that the patient is on dialysis appears to add no additional information.
- Patients with no angina have higher risk of in–hospital death than patients reported as having either "stable" or "unstable angina." Patients with no angina are unusual in that the majority of patients undergoing isolated CABG surgery have either "stable" or "unstable angina." Table F–1 (**Technical Appendix**) shows that only about 10% of the patients are classified as having "angina, none."
- The New York Heart Association (NYHA) Class, used to measure the severity of congestive heart failure, appears to make a "natural" split between NYHA Class I and NYHA Classes II, III, and IV.
- Canadian Cardiovascular Society (CCS) Class, used to measure the severity of angina, does not appear to have much explanatory power. Since the majority of CABG patients suffer from Class III or Class IV anginal pain, there is probably insufficient variability in these data to distinguish mortality differentials.

- The coefficients on the Myocardial Infarction (MI) variable seem to indicate that an MI more than one week before the CABG procedure has an effect on risk indistinguishable from no MI at all, even after controlling for the acuity of the operation.
- Moderate amounts of stenosis of the Left Main coronary artery (up to about 70% stenosis) do not appear to have a significant elevating effect on the risk of in–hospital mortality. Stenosis beyond the 70% level appears to have a much larger effect. Note that the usual analysis might conclude that a 75% stenosis is statistically indistinguishable from no stenosis because the t–statistic is less than 2.0 (it is 1.78).[9]
- Among the collected comorbidities, peripheral vascular disease appears to have the largest effect.
- The number of vessels affected with coronary disease appears to have an effect in the hypothesized direction. The risk of death increases (ie., with greater a number of vessels affected), but the effect is not statistically distinguishable from no effect.
- While "moderate" and "severe" mitral regurgitation appear to have effects as would be expected from a clinical standpoint, "mild" regurgitation is anomalous in appearing to have a lesser effect than "trivial." This may result from coding confusion between these two categories and CCMRP intends to focus on this distinction in future data collection training sessions.

[9] For the year 2000, the STS Adult Cardiac Database will be collecting data only on whether stenosis of the left main coronary artery exceeds 50% and will no longer collect data on the degree to which stenosis is beyond 50%.

VI. RISK–ADJUSTED HOSPITAL MORTALITY RATES FOR 1997–1998

In the 1997–1998 CCMRP data set used to develop the risk–adjustment model, a total of 802 patients of 30,814 died in–hospital following the isolated CABG procedure. This results in an overall in–hospital mortality rate of 2.6%. In contrast, the New York State Department of Health reported an in–hospital mortality rate of 2.15% for New York hospitals For 1998 (see www.health.state.ny.us).

The logistic regression model in the previous section (see Table 4) was used to develop risk-adjusted mortality statistics for each of the participating hospitals. Risk adjusting hospital mortality rates allows a fair comparison across hospitals by controlling for differences in patient case-mix. Specifically, the risk-adjustment model calculates the *expected number* of in-hospital deaths for isolated CABG patients in each hospital, and the *expected mortality rate* for each hospital.

The tables and graphics that follow provide two important pieces of information about each hospital's performance:

The observed to expected mortality ratio (O/E ratio): The O/E ratio is the *number of observed (actual) deaths* for the hospital, divided by the *number of expected deaths* for the hospital (as determined from the risk–adjustment model). If the O/E ratio is higher than 1.0, it means that the hospital had more deaths than would have been expected given the case-mix of its patients. If the number is lower than 1.0, it means that the hospital had fewer deaths than would have been expected given the case-mix of its patients. **Small differences in the O/E ratio are usually not significant.** Hospitals that have O/E ratios of less than or greater than one are not classified as better or worse than expected unless the result has also been found to be statistically significant.

Classification into a rating category (better than expected/worse than expected/no different than expected): The performance category a hospital falls into is dependent on the hospital's observed death rate in relation to the *95% confidence interval* around the *expected death rate*. Specifically, statistical significance of a hospital's result is determined by the following:

- If the *observed death rate* is higher than the upper bound of the 95% confidence interval of the *expected death rate*, then the hospital's performance is classified as worse than expected.
- If the *observed death rate* is lower than the lower bound of the 95% confidence interval of the *expected death rate*, then the hospital's performance is classified as better than expected.

This comparison of the *observed mortality* rate to the confidence interval around the *expected mortality rate* is a test of statistical significance. An *observed rate* outside the 95% confidence interval of the *expected rate*, indicates with reasonable confidence that the hospital's performance is either better or worse than expected.

A series of tables (Tables 5 and 6) and figures (Figures 2 and 3) present the risk–adjusted results for the 79 CCMRP–participating hospitals for the 1997 and 1998 data submission period. Tables 5 and 6 present detailed numerical results, first displayed alphabetically by hospital and then displayed in ascending order of each hospital's O/E Ratio. The figures that follow present the results graphically, sorted alphabetically by overall performance rating and by geographic region.

It is critical to recognize that, regardless of any individual hospital's performance results, participation in CCMRP represents a significant commitment to quality measurement and improvement by each participating hospital. It is equally important to note that the overall performance rating—that is whether the hospital performed differently than expected—may have been different if data from the 38 non–participating hospitals were included.

How to Read Tables 5 and 6

Number of CABG cases submitted: This column denotes the number of isolated CABG cases the hospital submitted to CCMRP for the 1997–1998 period. Some hospitals began submitting data in 1997, while others began in 1998. Whatever the starting date, we combined all data from all participating hospitals to construct the 1997–1998 risk adjustment model. The total number of cases from the 79 hospitals that publicly report their results is 28,597. The 1997–1998 data set used to compute the risk model includes data from 82 hospitals, representing 30,814 cases.

Number of observed deaths: This is the *actual* number of in–hospital deaths the hospital submitted to CCMRP for isolated CABG patients during the 1997–1998 period. This number does not include patients who died after transfer or discharge from the facility. There were 802 in–hospital deaths in our 1997–1998 data set.

Number of expected deaths: CCMRP used the risk–adjustment model to calculate the probability of in–hospital death for each one of the 30,814 cases in the 1997–1998 data set. CCMRP staff then summed the probabilities for all cases at any one hospital to calculate the number of in–hospital deaths we would expect at the hospital given its case–mix. For example, if Hospital X had 150 patients, 100 of whom had a 1% probability of death, 40 of whom had a 4% probability of death, and 10 with a 9% probability of death, the total number of expected deaths would be 3.5 (i.e., (100)(1%) + (40)(4%) + (10)(9%) = 1 + 1.6 + 0.9 = 3.5 expected deaths). Note that the *number of expected deaths* can be a fractional number, unlike the *number of observed deaths*—which can only be a whole number.

The O/E ratio: Dividing the *observed death rate* by the *expected death rate* produces the O/E ratio. This ratio is a quick method for assessing hospital performance. If the hospital had fewer actual deaths than expected, the O/E ratio will be less than 1.0. If the hospital had more deaths than expected, the O/E ratio will be greater than 1.0. If, as in the previous example, the *observed death rate* was 2.8% while the *expected death rate* was 3.28%, the hospital's O/E ratio would be 2.8%/3.28% = 0.854.

Observed death rate: This is the actual death rate for the hospital. It is calculated by dividing the *number of observed deaths* for the hospital by the *number of cases* for the hospital in the

1997–1998 period. For example, if the hospital had 250 isolated CABG cases in 1997–1998, with seven actual in–hospital deaths, the observed death rate would be 7/250 = 2.8%.

Expected death rate: The *number of expected deaths* is divided by the *number of cases* to derive the *expected death rate*. If the hospital had 250 isolated CABG cases in 1997–1998 and an expected number of in–hospital deaths of 8.2, the *expected death rate* would be 8.2/250 = 3.28%. Note that the *expected death rate* is a measure of the average severity of illness of each hospital's isolated CABG patients: the higher the expected rate, the higher the average severity. The average death rate for the entire 1997–1998 data set is 802/30,814 = 2.60%, so if the *expected death rate* is higher than 2.6% the hospital's isolated CABG patients tend to be higher risk than the overall population of CABG patients in CCMRP's data set.

The lower and upper confidence intervals on the expected death rate: Assuming that the risk adjustment model is correct, we can calculate the standard deviation for the *number of expected deaths* at each hospital. Because there is a great deal of variability in patient risks, the CCMRP model calculates the standard deviation based on the predictions of risk for each patient rather than using the average risk over all patients at each hospital. A lower confidence limit bound on the *expected rate* is computed by subtracting twice the standard deviation from the *expected rate*. Similarly the upper bound is calculated by adding twice the standard deviation to the *expected rate*. Two standard deviations (2SD) below and above the *expected rate* is an approximate 95% confidence interval.

In general, if the upper and lower bounds of the *expected death rate* are close together, the expected rate is fairly reliably estimated. The width of the confidence interval depends both on the number of cases that a hospital submitted, and the variability of the difference in the risks for the hospital's isolated CABG patients. A hospital that had more cases to CCMRP will tend to have a narrower confidence interval than a hospital that had less, which provides a more reliable idea of its overall performance.

Overall performance rating: The hospital's overall performance rating is based on a comparison of each facility's *observed death rate* to the 95% confidence interval around the hospital's *expected death rate*. This is a test of statistical significance. Effectively, hospitals are only classified as "better" or "worse" than expected if their *observed mortality rate* falls outside the 95% confidence interval of the *expected death rate*. CCMRP splits all hospitals into three groups, "better than expected," "worse than expected," and "no different than expected." For ease of reading, a blank in this column indicates a hospital's actual performance is *no different than expected.*

Better than Expected ★	**Hospital's observed mortality rate is:**	**Less than**	**Lower confidence interval of expected mortality rate**
Worse than Expected ▼	**Hospital's observed mortality rate is:**	**Greater than**	**Upper confidence interval of expected mortality rate**
No Different than Expected	**Hospital's observed mortality rate:**	**Falls within**	**Upper and lower confidence interval of expected mortality rate**

Table 5: Risk–Adjusted Results for CCMRP Hospitals, 1997–1998, Sorted Alphabetically

Name	Total CABG Cases Submitted	Number of Observed Deaths	Number of Expected Deaths	O/E Ratio	Observed Death Rate	Lower 95% CI of Expected Death Rate	Expected Death Rate	Upper 95% CI of Expected Death Rate	Overall Performance Rating (blank = no different than expected)
ALTA BATES MEDICAL CENTER	276	11	7.29	1.51	3.99	0.83	2.64	4.46	
ALVARADO HOSPITAL MEDICAL CENTER	298	16	10.71	1.49	5.37	1.51	3.59	5.68	
ANAHEIM MEMORIAL MEDICAL CENTER	130	4	3.08	1.30	3.08	0.00	2.37	4.89	
CALIFORNIA PAC MED CTR—PACIFIC CAMPUS	176	6	3.47	1.73	3.41	0.00	1.97	4.03	
CEDARS–SINAI MEDICAL CENTER	868	19	21.54	0.88	2.19	1.46	2.48	3.50	
CITRUS VALLEY MEDICAL CENTER–IC CAMPUS	430	16	14.35	1.12	3.72	1.65	3.34	5.03	
COMMUNITY MEM HOSP—SAN BUENAVENTURA	202	4	3.81	1.05	1.98	0.00	1.89	3.78	
DAMERON HOSPITAL	107	3	3.97	0.76	2.80	0.30	3.71	7.11	
DANIEL FREEMAN MEMORIAL HOSPITAL	173	2	3.86	0.52	1.16	0.01	2.23	4.44	
DESERT REGIONAL MEDICAL CENTER	122	5	2.91	1.72	4.10	0.00	2.39	5.12	
DOCTORS MEDICAL CENTER—SAN PABLO	169	3	7.28	0.41	1.78	1.42	4.31	7.21	
DOCTORS MEDICAL CENTER—MODESTO	451	11	8.22	1.34	2.44	0.57	1.82	3.07	
DOMINICAN SANTA CRUZ HOSPITAL—SOQUEL	272	10	7.84	1.28	3.68	0.98	2.88	4.79	
DOWNEY COMMUNITY HOSPITAL ▼	239	13	6.53	1.99	5.44	0.72	2.73	4.75	Worse than Expected
EL CAMINO HOSPITAL	52	1	2.14	0.47	1.92	0.00	4.11	8.96	
ENCINO TARZANA REGIONAL MEDICAL CENTER	145	2	7.17	0.28	1.38	1.36	4.94	8.53	
GLENDALE ADVENTIST MEDICAL CENTER	203	7	6.35	1.10	3.45	0.83	3.13	5.43	
GLENDALE MEM HOSPITAL AND HEALTH CTR	223	8	10.98	0.73	3.59	2.13	4.92	7.72	
GRANADA HILLS COMMUNITY HOSPITAL	142	4	2.13	1.88	2.82	0.00	1.50	3.52	
HOAG MEMORIAL HOSPITAL PRESBYTERIAN ★	496	9	17.98	0.50	1.81	2.03	3.63	5.22	Better than Expected
JOHN MUIR MEDICAL CENTER ▼	128	9	2.97	3.03	7.03	0.00	2.32	4.91	Worse than Expected
KAISER FOUNDATION HOSP—GEARY (S.F.)	992	21	18.58	1.13	2.12	1.05	1.87	2.69	
KAISER FOUNDATION HOSP—SUNSET (L.A.)	2302	31	37.66	0.82	1.35	1.12	1.64	2.15	
KAWEAH DELTA DISTRICT HOSPITAL	562	9	16.51	0.55	1.60	1.59	2.94	4.28	
LANCASTER COMMUNITY HOSPITAL	23	0	0.76	0.00	0.00	0.00	3.31	9.49	
LITTLE COMPANY OF MARY HOSPITAL	160	4	3.84	1.04	2.50	0.03	2.40	4.77	

★ Better than expected mortality rate, ▼ Worse than expected mortality rate.

Table 5: Risk–Adjusted Results for CCMRP Hospitals, 1997–1998, Sorted Alphabetically (cont.)

Name	Total CABG Cases Submitted	Number of Observed Deaths	Number of Expected Deaths	O/E Ratio	Observed Death Rate	Lower 95% CI of Expected Death Rate	Expected Death Rate	Upper 95% CI of Expected Death Rate	Overall Performance Rating (blank = no different than expected)
LONG BEACH MEMORIAL MEDICAL CENTER	378	7	12.01	0.58	1.85	1.42	3.18	4.93	
LOS ANGELES CO USC MEDICAL CENTER	146	4	2.87	1.39	2.74	0.00	1.96	4.20	
MARIN GENERAL HOSPITAL	94	2	1.74	1.15	2.13	0.00	1.85	4.59	
MEDICAL CENTER AT THE UCSF	141	7	3.95	1.77	4.96	0.29	2.80	5.30	
MEMORIAL HOSPITAL MODESTO	550	16	11.55	1.39	2.91	0.89	2.10	3.31	
MERCY GENERAL HOSPITAL	2565	32	38.37	0.83	1.25	1.03	1.50	1.97	
MERCY MEDICAL CENTER—REDDING	114	3	5.49	0.55	2.63	1.05	4.82	8.58	
MERCY SAN JUAN HOSPITAL ▼	408	17	7.92	2.15	4.17	0.60	1.94	3.28	Worse than Expected
METHODIST HOSPITAL OF SOUTHERN CAL	428	17	14.26	1.19	3.97	1.64	3.33	5.02	
MILLS—PENINSULA MEDICAL CENTER	323	14	8.92	1.57	4.33	1.04	2.76	4.48	
MT DIABLO MEDICAL CENTER	561	20	15.91	1.26	3.57	1.49	2.84	4.18	
NORTHRIDGE HOSPITAL MEDICAL CENTER	301	9	8.91	1.01	2.99	1.04	2.96	4.88	
PALOMAR MEDICAL CENTER	349	13	11.08	1.17	3.72	1.40	3.18	4.95	
POMONA VALLEY HOSPITAL MEDICAL CENTER	527	18	13.11	1.37	3.42	1.19	2.49	3.79	
PRESBYTERIAN INTERCOMMUNITY HOSPITAL ▼	117	9	4.55	1.98	7.69	0.69	3.89	7.08	Worse than Expected
PROVIDENCE HOLY CROSS MEDICAL CENTER	114	3	2.70	1.11	2.63	0.00	2.37	5.19	
PROVIDENCE SAINT JOSEPH MEDICAL CENTER	232	3	3.74	0.80	1.29	0.00	1.61	3.25	
REDDING MEDICAL CENTER	1037	14	16.22	0.86	1.35	0.81	1.56	2.32	
RIVERSIDE COMMUNITY HOSPITAL	86	7	4.57	1.53	8.14	1.00	5.32	9.64	
SADDLEBACK MEMORIAL MEDICAL CENTER	175	9	8.03	1.12	5.14	1.52	4.59	7.66	
SALINAS VALLEY MEMORIAL HOSPITAL	135	2	3.88	0.52	1.48	0.08	2.87	5.67	
SAN ANTONIO COMMUNITY HOSPITAL	124	3	7.56	0.40	2.42	2.25	6.10	9.94	
SANTA BARBARA COTTAGE HOSPITAL	267	9	6.75	1.33	3.37	0.65	2.53	4.41	
SANTA MONICA—UCLA MEDICAL CENTER	45	2	1.25	1.60	4.44	0.00	2.78	7.64	
SCRIPPS MEMORIAL HOSPITAL—LA JOLLA	674	15	19.92	0.75	2.23	1.74	2.96	4.17	

★ Better than expected mortality rate, ▼ Worse than expected mortality rate.

Table 5: Risk–Adjusted Results for CCMRP Hospitals, 1997–1998, Sorted Alphabetically (cont.)

Name	Total CABG Cases Submitted	Number of Observed Deaths	Number of Expected Deaths	O/E Ratio	Observed Death Rate	Lower 95% CI of Expected Death Rate	Expected Death Rate	Upper 95% CI of Expected Death Rate	Overall Performance Rating (blank = no different than expected)
SEQUOIA HOSPITAL	483	18	21.36	0.84	3.73	2.67	4.42	6.18	
SETON MEDICAL CENTER	1249	18	22.21	0.81	1.44	1.04	1.78	2.52	
SHARP CHULA VISTA MEDICAL CENTER	531	23	18.94	1.21	4.33	2.01	3.57	5.12	
SHARP GROSSMONT HOSPITAL	133	1	2.34	0.43	0.75	0.00	1.76	4.02	
SHARP MEMORIAL HOSPITAL	304	4	5.24	0.76	1.32	0.25	1.73	3.20	
ST. BERNARDINE MEDICAL CENTER	405	11	14.40	0.76	2.72	1.76	3.56	5.35	
ST. FRANCIS MEDICAL CENTER	62	3	3.39	0.89	4.84	0.00	5.46	11.00	
ST. HELENA HOSPITAL & HEALTH CENTER	419	8	11.27	0.71	1.91	1.15	2.69	4.23	
ST. JOHN'S HOSPITAL—SANTA MONICA	256	5	6.80	0.74	1.95	0.72	2.66	4.60	
ST. JOHN'S REGIONAL MED CENTER—OXNARD	90	2	2.91	.69	2.22	0.00	3.24	6.84	
ST. JOSEPH HOSPITAL—ORANGE	293	8	6.57	1.22	2.73	0.54	2.24	3.94	
ST. JOSEPH'S MEDICAL CENTER OF STOCKTON	610	20	17.31	1.16	3.28	1.55	2.84	4.13	
ST. JUDE MEDICAL CENTER	205	8	5.13	1.56	3.90	0.40	2.50	4.61	
ST. MARY MEDICAL CENTER—LONG BEACH	87	7	5.82	1.20	8.05	1.60	6.69	11.78	
ST. VINCENT MEDICAL CENTER	74	2	2.14	0.93	2.70	0.00	2.89	6.65	
STANFORD UNIVERSITY HOSPITAL	269	10	6.23	1.61	3.72	0.51	2.31	4.12	
SUMMIT MEDICAL CENTER ★	325	5	11.85	0.42	1.54	1.73	3.65	5.57	Better than Expected
SUTTER MEMORIAL HOSPITAL ★	1534	25	42.71	0.59	1.63	1.99	2.78	3.58	Better than Expected
THE HEART HOSPITAL, INC.	133	1	3.58	0.28	0.75	0.00	2.69	5.39	
TORRANCE MEMORIAL MEDICAL CENTER	401	20	16.72	1.20	4.99	2.33	4.17	6.01	
TRI–CITY MEDICAL CENTER	431	7	10.31	0.68	1.62	0.97	2.39	3.82	
UCLA MEDICAL CENTER	191	7	6.10	1.15	3.66	0.81	3.19	5.57	
UC SAN DIEGO UNIVERSITY MEDICAL CENTER (THORTON AND HILLCREST)	191	9	7.39	1.22	4.71	1.17	3.87	6.57	
UCSF/MT ZION	44	2	1.40	1.43	4.55	0.00	3.18	8.40	
UNIVERSITY OF CALIFORNIA DAVIS MED CTR	74	2	1.62	1.23	2.70	0.00	2.19	5.52	

★ Better than expected mortality rate, ▼ Worse than expected mortality rate.

Table 5: Risk–Adjusted Results for CCMRP Hospitals, 1997–1998, Sorted Alphabetically (cont.)

Name	Total CABG Cases Submitted	Number of Observed Deaths	Number of Expected Deaths	O/E Ratio	Observed Death Rate	Lower 95% CI of Expected Death Rate	Expected Death Rate	Upper 95% CI of Expected Death Rate	Overall Performance Rating (blank = no different than expected)
UNIVERSITY OF CALIFORNIA IRVINE MED CTR	94	0	3.13	0.00	0.00	0.00	3.33	6.89	
USC UNIVERSITY HOSPITAL	144	4	2.74	1.46	2.78	0.00	1.90	4.15	
WASHINGTON HOSPITAL—FREMONT	334	14	17.07	0.82	4.19	2.92	5.11	7.30	

★ Better than expected mortality rate, ▼ Worse than expected mortality rate.

Table 6: Risk–Adjusted Results for CCMRP Hospitals, 1997–1998, Sorted by O/E Ratio

Name	Total CABG Cases Submitted	Number of Observed Deaths	Number of Expected Deaths	O/E Ratio	Observed Death Rate	Lower 95% CI of Expected Death Rate	Expected Death Rate	Upper 95% CI of Expected Death Rate	Overall Performance Rating (blank = no different than expected)
LANCASTER COMMUNITY HOSPITAL	23	0	0.76	0.00	0.00	0.00	3.31	9.49	
UNIVERSITY OF CALIFORNIA IRVINE MED CTR	94	0	3.13	0.00	0.00	0.00	3.33	6.89	
ENCINO TARZANA REGIONAL MEDICAL CENTER	145	2	7.17	0.28	1.38	1.36	4.94	8.53	
THE HEART HOSPITAL, INC.	133	1	3.58	0.28	0.75	0.00	2.69	5.39	
SAN ANTONIO COMMUNITY HOSPITAL	124	3	7.56	0.40	2.42	2.25	6.10	9.94	
DOCTORS MEDICAL CENTER—SAN PABLO	169	3	7.28	0.41	1.78	1.42	4.31	7.21	
SUMMIT MEDICAL CENTER ★	325	5	11.85	0.42	1.54	1.73	3.65	5.57	Better than Expected
SHARP GROSSMONT HOSPITAL	133	1	2.34	0.43	0.75	0.00	1.76	4.02	
EL CAMINO HOSPITAL	52	1	2.14	0.47	1.92	0.00	4.11	8.96	
HOAG MEMORIAL HOSPITAL PRESBYTERIAN ★	496	9	17.98	0.50	1.81	2.03	3.63	5.22	Better than Expected
SALINAS VALLEY MEMORIAL HOSPITAL	135	2	3.88	0.52	1.48	0.08	2.87	5.67	
DANIEL FREEMAN MEMORIAL HOSPITAL	173	2	3.86	0.52	1.16	0.01	2.23	4.44	
KAWEAH DELTA DISTRICT HOSPITAL	562	9	16.51	0.55	1.60	1.59	2.94	4.28	
MERCY MEDICAL CENTER—REDDING	114	3	5.49	0.55	2.63	1.05	4.82	8.58	
LONG BEACH MEMORIAL MEDICAL CENTER	378	7	12.01	0.58	1.85	1.42	3.18	4.93	
SUTTER MEMORIAL HOSPITAL ★	1534	25	42.71	0.59	1.63	1.99	2.78	3.58	Better than Expected
TRI–CITY MEDICAL CENTER	431	7	10.31	0.68	1.62	0.97	2.39	3.82	
ST. JOHN'S REGIONAL MED CENTER—OXNARD	90	2	2.91	0.69	2.22	0.00	3.24	6.84	
ST. HELENA HOSPITAL & HEALTH CENTER	419	8	11.27	0.71	1.91	1.15	2.69	4.23	
GLENDALE MEM HOSPITAL & HEALTH CTR	223	8	10.98	0.73	3.59	2.13	4.92	7.72	
ST. JOHN'S HOSPITAL—SANTA MONICA	256	5	6.80	0.74	1.95	0.72	2.66	4.60	
SCRIPPS MEMORIAL HOSPITAL—LA JOLLA	674	15	19.92	0.75	2.23	1.74	2.96	4.17	
DAMERON HOSPITAL	107	3	3.97	0.76	2.80	0.30	3.71	7.11	
SHARP MEMORIAL HOSPITAL	304	4	5.24	0.76	1.32	0.25	1.73	3.20	
ST. BERNARDINE MEDICAL CENTER	405	11	14.40	0.76	2.72	1.76	3.56	5.35	

★ Better than expected mortality rate, ▼ Worse than expected mortality rate.

Table 6: Risk–Adjusted Results for CCMRP Hospitals, 1997–1998, Sorted by O/E Ratio (cont.)

Name	Total CABG Cases Submitted	Number of Observed Deaths	Number of Expected Deaths	O/E Ratio	Observed Death Rate	Lower 95% CI of Expected Death Rate	Expected Death Rate	Upper 95% CI of Expected Death Rate	Overall Performance Rating (blank = no (blank = no different than expected)
PROVIDENCE SAINT JOSEPH MEDICAL CENTER	232	3	3.74	0.80	1.29	0.00	1.61	3.25	
SETON MEDICAL CENTER	1249	18	22.21	0.81	1.44	1.04	1.78	2.52	
WASHINGTON HOSPITAL—FREMONT	334	14	17.07	0.82	4.19	2.92	5.11	7.30	
KAISER FOUNDATION HOSP—SUNSET (L.A.)	2302	31	37.66	0.82	1.35	1.12	1.64	2.15	
MERCY GENERAL HOSPITAL	2565	32	38.37	0.83	1.25	1.03	1.50	1.97	
SEQUOIA HOSPITAL	483	18	21.36	0.84	3.73	2.67	4.42	6.18	
REDDING MEDICAL CENTER	1037	14	16.22	0.86	1.35	0.81	1.56	2.32	
CEDARS—SINAI MEDICAL CENTER	868	19	21.54	0.88	2.19	1.46	2.48	3.50	
ST. FRANCIS MEDICAL CENTER	62	3	3.39	0.89	4.84	0.00	5.46	11.00	
ST. VINCENT MEDICAL CENTER	74	2	2.14	0.93	2.70	0.00	2.89	6.65	
NORTHRIDGE HOSPITAL MEDICAL CENTER	301	9	8.91	1.01	2.99	1.04	2.96	4.88	
LITTLE COMPANY OF MARY HOSPITAL	160	4	3.84	1.04	2.50	0.03	2.40	4.77	
COMMUNITY MEM HOSP—SAN BUENAVENTURA	202	4	3.81	1.05	1.98	0.00	1.89	3.78	
GLENDALE ADVENTIST MEDICAL CENTER	203	7	6.35	1.10	3.45	0.83	3.13	5.43	
PROVIDENCE HOLY CROSS MEDICAL CENTER	114	3	2.70	1.11	2.63	0.00	2.37	5.19	
CITRUS VALLEY MEDICAL CENTER—IC CAMPUS	430	16	14.35	1.12	3.72	1.65	3.34	5.03	
SADDLEBACK MEMORIAL MEDICAL CENTER	175	9	8.03	1.12	5.14	1.52	4.59	7.66	
KAISER FOUNDATION HOSP—GEARY (S.F.)	992	21	18.58	1.13	2.12	1.05	1.87	2.69	
UCLA MEDICAL CENTER	191	7	6.10	1.15	3.66	0.81	3.19	5.57	
MARIN GENERAL HOSPITAL	94	2	1.74	1.15	2.13	0.00	1.85	4.59	
ST. JOSEPH'S MEDICAL CENTER OF STOCKTON	610	20	17.31	1.16	3.28	1.55	2.84	4.13	
PALOMAR MEDICAL CENTER	349	13	11.08	1.17	3.72	1.40	3.18	4.95	
METHODIST HOSPITAL OF SOUTHERN CAL	428	17	14.26	1.19	3.97	1.64	3.33	5.02	
TORRANCE MEMORIAL MEDICAL CENTER	401	20	16.72	1.20	4.99	2.33	4.17	6.01	
ST. MARY MEDICAL CENTER—LONG BEACH	87	7	5.82	1.20	8.05	1.60	6.69	11.78	

★ Better than expected mortality rate, ▼ Worse than expected mortality rate.

Table 6: Risk–Adjusted Results for CCMRP Hospitals, 1997–1998, Sorted by O/E Ratio (cont.)

Name	Total CABG Cases Submitted	Number of Observed Deaths	Number of Expected Deaths	O/E Ratio	Observed Death Rate	Lower 95% CI of Expected Death Rate	Expected Death Rate	Upper 95% CI of Expected Death Rate	Overall Performance Rating (blank = no different than expected)
SHARP CHULA VISTA MEDICAL CENTER	531	23	18.94	1.21	4.33	2.01	3.57	5.12	
UC SAN DIEGO UNIVERSITY MEDICAL CENTER (THORTON AND HILLCREST)	191	9	7.39	1.22	4.71	1.17	3.87	6.57	
ST. JOSEPH HOSPITAL—ORANGE	293	8	6.57	1.22	2.73	0.54	2.24	3.94	
UNIVERSITY OF CALIFORNIA DAVIS MED CTR	74	2	1.62	1.23	2.70	0.00	2.19	5.52	
MT DIABLO MEDICAL CENTER	561	20	15.91	1.26	3.57	1.49	2.84	4.18	
DOMINICAN SANTA CRUZ HOSPITAL—SOQUEL	272	10	7.84	1.28	3.68	0.98	2.88	4.79	
ANAHEIM MEMORIAL MEDICAL CENTER	130	4	3.08	1.30	3.08	0.00	2.37	4.89	
SANTA BARBARA COTTAGE HOSPITAL	267	9	6.75	1.33	3.37	0.65	2.53	4.41	
DOCTORS MEDICAL CENTER MODESTO	451	11	8.22	1.34	2.44	0.57	1.82	3.07	
POMONA VALLEY HOSPITAL MEDICAL CENTER	527	18	13.11	1.37	3.42	1.19	2.49	3.79	
MEMORIAL HOSPITAL MODESTO	550	16	11.55	1.39	2.91	0.89	2.10	3.31	
LOS ANGELES CO USC MEDICAL CENTER	146	4	2.87	1.39	2.74	0.00	1.96	4.20	
UCSF/MT ZION	44	2	1.40	1.43	4.55	0.00	3.18	8.40	
USC UNIVERSITY HOSPITAL	144	4	2.74	1.46	2.78	0.00	1.90	4.15	
ALVARADO HOSPITAL MEDICAL CENTER	298	16	10.71	1.49	5.37	1.51	3.59	5.68	
ALTA BATES MEDICAL CENTER	276	11	7.29	1.51	3.99	0.83	2.64	4.46	
RIVERSIDE COMMUNITY HOSPITAL	86	7	4.57	1.53	8.14	1.00	5.32	9.64	
ST. JUDE MEDICAL CENTER	205	8	5.13	1.56	3.90	0.40	2.50	4.61	
MILLS–PENINSULA MEDICAL CENTER	323	14	8.92	1.57	4.33	1.04	2.76	4.48	
SANTA MONICA—UCLA MEDICAL CENTER	45	2	1.25	1.60	4.44	0.00	2.78	7.64	
STANFORD UNIVERSITY HOSPITAL	269	10	6.23	1.61	3.72	0.51	2.31	4.12	
DESERT REGIONAL MEDICAL CENTER	122	5	2.91	1.72	4.10	0.00	2.39	5.12	
CALIFORNIA PAC MED CTR—PACIFIC CAMPUS	176	6	3.47	1.73	3.41	0.00	1.97	4.03	
MEDICAL CENTER AT THE UCSF	141	7	3.95	1.77	4.96	0.29	2.80	5.30	
GRANADA HILLS COMMUNITY HOSPITAL	142	4	2.13	1.88	2.82	0.00	1.50	3.52	

★ Better than expected mortality rate, ▼ Worse than expected mortality rate.

Table 6: Risk–Adjusted Results for CCMRP Hospitals, 1997–1998, Sorted by O/E Ratio (cont.)

Name	Total CABG Cases Submitted	Number of Observed Deaths	Number of Expected Deaths	O/E Ratio	Observed Death Rate	Lower 95% CI of Expected Death Rate	Expected Death Rate	Upper 95% CI of Expected Death Rate	Overall Performance Rating (blank = no different than expected)
PRESBYTERIAN INTERCOMMUNITY HOSPITAL ▼	117	9	4.55	1.98	7.69	0.69	3.89	7.08	Worse than Expected
DOWNEY COMMUNITY HOSPITAL ▼	239	13	6.53	1.99	5.44	0.72	2.73	4.75	Worse than Expected
MERCY SAN JUAN HOSPITAL ▼	408	17	7.92	2.15	4.17	0.60	1.94	3.28	Worse than Expected
JOHN MUIR MEDICAL CENTER ▼	128	9	2.97	3.03	7.03	0.00	2.32	4.91	Worse than Expected

★ Better than expected mortality rate, ▼ Worse than expected mortality rate.

How to Read Figures 2 and 3

The O/E ratio: Dividing the *observed death rate* by the *expected death rate* produces the O/E ratio. If the hospital had fewer actual deaths than expected, the O/E ratio will be less than 1.0. If the hospital had more deaths than expected, the O/E ratio will be greater than 1.0.

Observed mortality rate: This is the actual death rate for the hospital. It is calculated by dividing the *number of observed deaths* for the hospital by the *number of cases* for the hospital in the 1997–1998 period.

The range of the expected mortality rate: The expected death rate is the *number of expected deaths* divided by the *number of cases.* CCMRP staff calculated the standard deviation for the *number of expected deaths* at each hospital. Because there is a great deal of variability in patient risks, it calculates the standard deviation based on the predictions of risk for each patient rather than using the average risk over all patients at each hospital. The box on the graph represents the 95% confidence interval around the *expected mortality rate*. A lower confidence limit bound on the *expected rate* is computed by subtracting twice the standard deviation from the *expected rate*. Similarly the upper bound is calculated by adding twice the standard deviation to the *expected rate*. Two standard deviations (2SD) below and above the *expected rate* is an approximate 95% confidence interval. In general, when the upper and lower bounds of the *expected death rate* are close together, that means that the expected rate is fairly reliably estimated. The width of the confidence interval depends both on the number of cases that a hospital submitted, and the variability of the difference in the risks for the hospital's isolated CABG patients. A hospital that submitted many cases to CCMRP will tend to have a narrower confidence interval than a hospital that did not, which provides a more reliable idea of its overall performance.

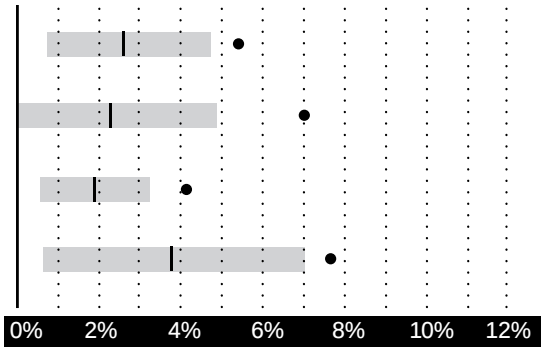
Overall performance rating: The hospital's overall rating is based on a comparison of each facility's *observed mortality rate* to the 95% confidence interval around the hospital's *expected mortality rate.* This is a test of statistical significance. Effectively, hospitals are only classified as "better" or "worse" than expected if their *observed mortality rate* falls outside the 95% confidence interval of the *expected mortality rate.*

Better than Expected ★	**Hospital's observed mortality rate is:**	**Less than**	**Lower confidence interval of expected mortality rate**
Worse than Expected ▼	**Hospital's observed mortality rate is:**	**Greater than**	**Upper confidence interval of expected mortality rate**
No Different than Expected	**Hospital's observed mortality rate:**	**Falls within**	**Upper and lower confidence interval of expected mortality rate**

Figure 2 **COMPARISON OF OBSERVED TO EXPECTED MORTALITY RATE, 1997 – 1998 (in Alphabetical Order by Performance Rating)**

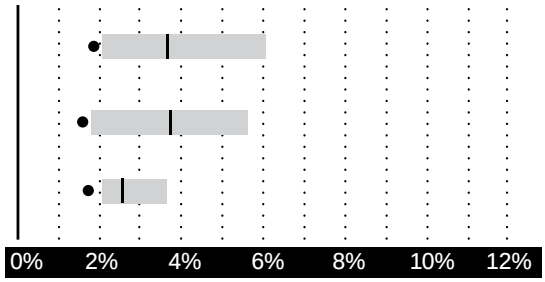
Hospitals Performing Worse than Expected

All California	O/E Ratio*
▼ Downey Community Hospital	1.99
▼ John Muir Medical Center	3.03
▼ Mercy San Juan Hospital	2.15
▼ Presbyterian Intercommunity Hospital	1.98



Hospitals Performing Better than Expected

All California	O/E Ratio*
★ Hoag Memorial Hospital Presbyterian	0.50
★ Summit Medical Center	0.42
★ Sutter Memorial Hospital	0.59



- • Observed Mortality Rate
- | Expected Mortality Rate
- ▒ Range of Expected Mortality Rate (95% Confidence Level)
- ▼ Observed Mortality Rate Significantly Worse than Expected
- ★ Observed Mortality Rate Significantly Better than Expected

*Observed to Expected Events Ratio

Figure 2 *(cont.)*

COMPARISON OF OBSERVED TO EXPECTED MORTALITY RATE, 1997 – 1998 (in Alphabetical Order by Performance Rating)

Hospitals Performing No Different Than Expected

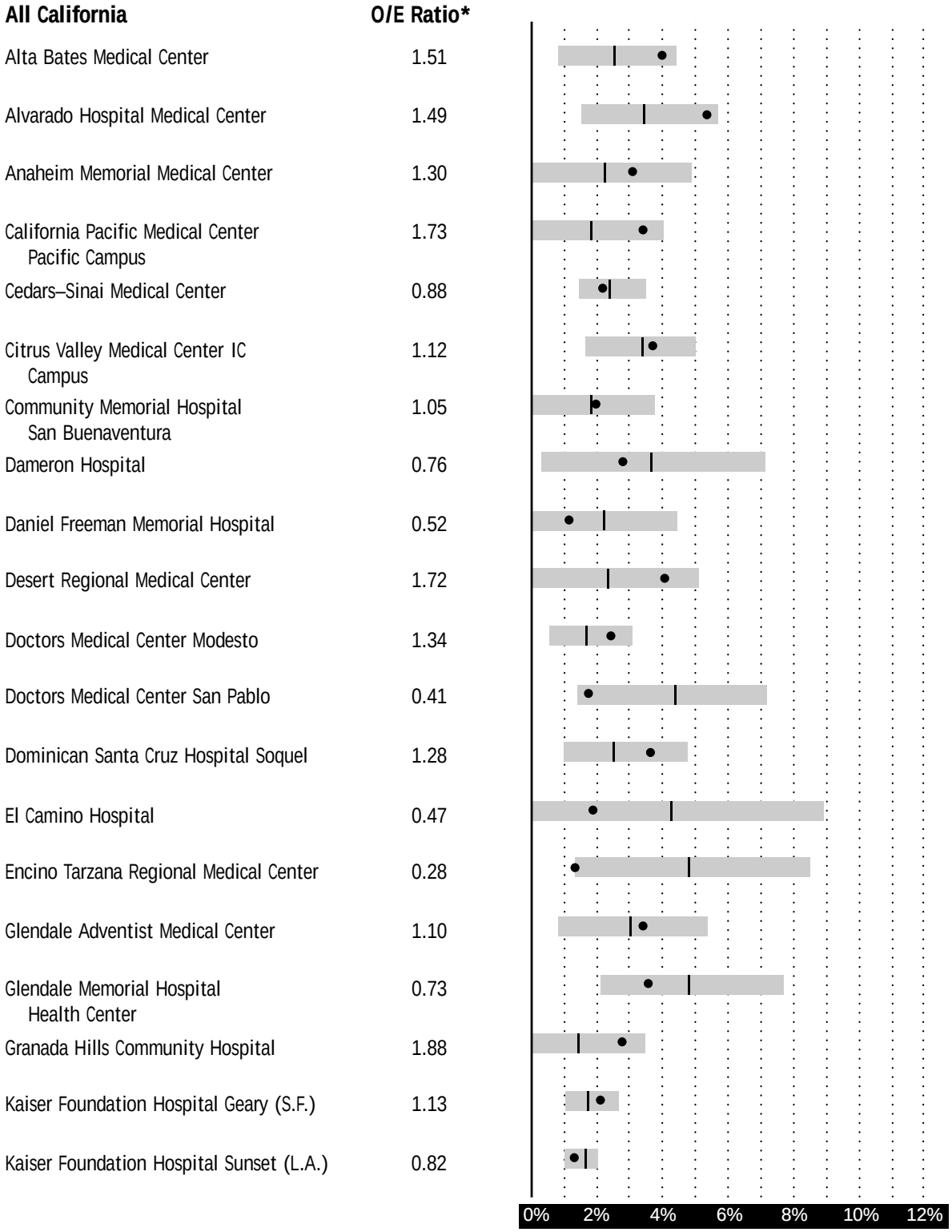


Figure 2 *(cont.)* **COMPARISON OF OBSERVED TO EXPECTED MORTALITY RATE, 1997 – 1998 (in Alphabetical Order by Performance Rating)**

Hospitals Performing No Different Than Expected

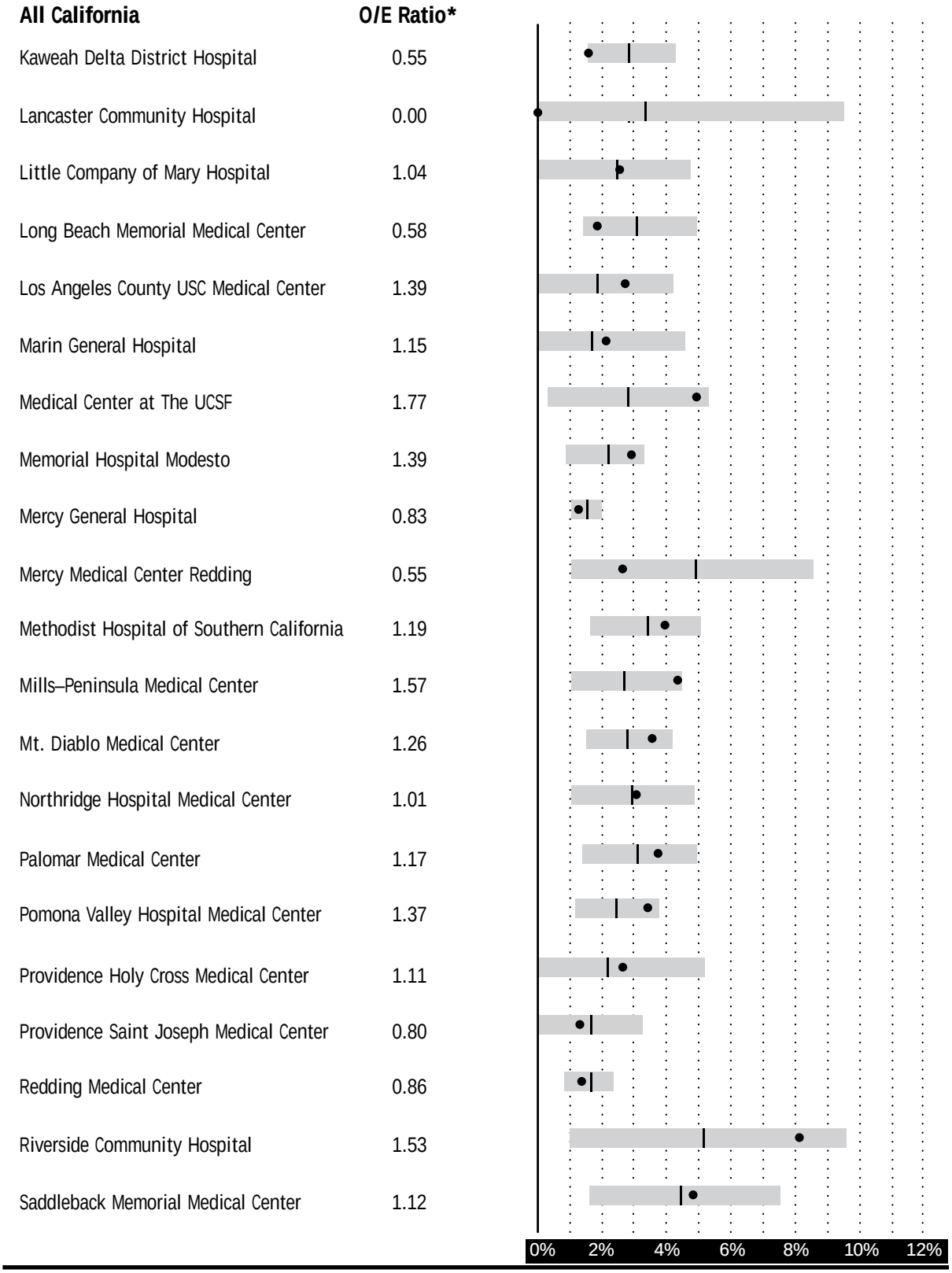


Figure 2 *(cont.)* **COMPARISON OF OBSERVED TO EXPECTED MORTALITY RATE, 1997 – 1998 (in Alphabetical Order by Performance Rating)**
Hospitals Performing No Different Than Expected

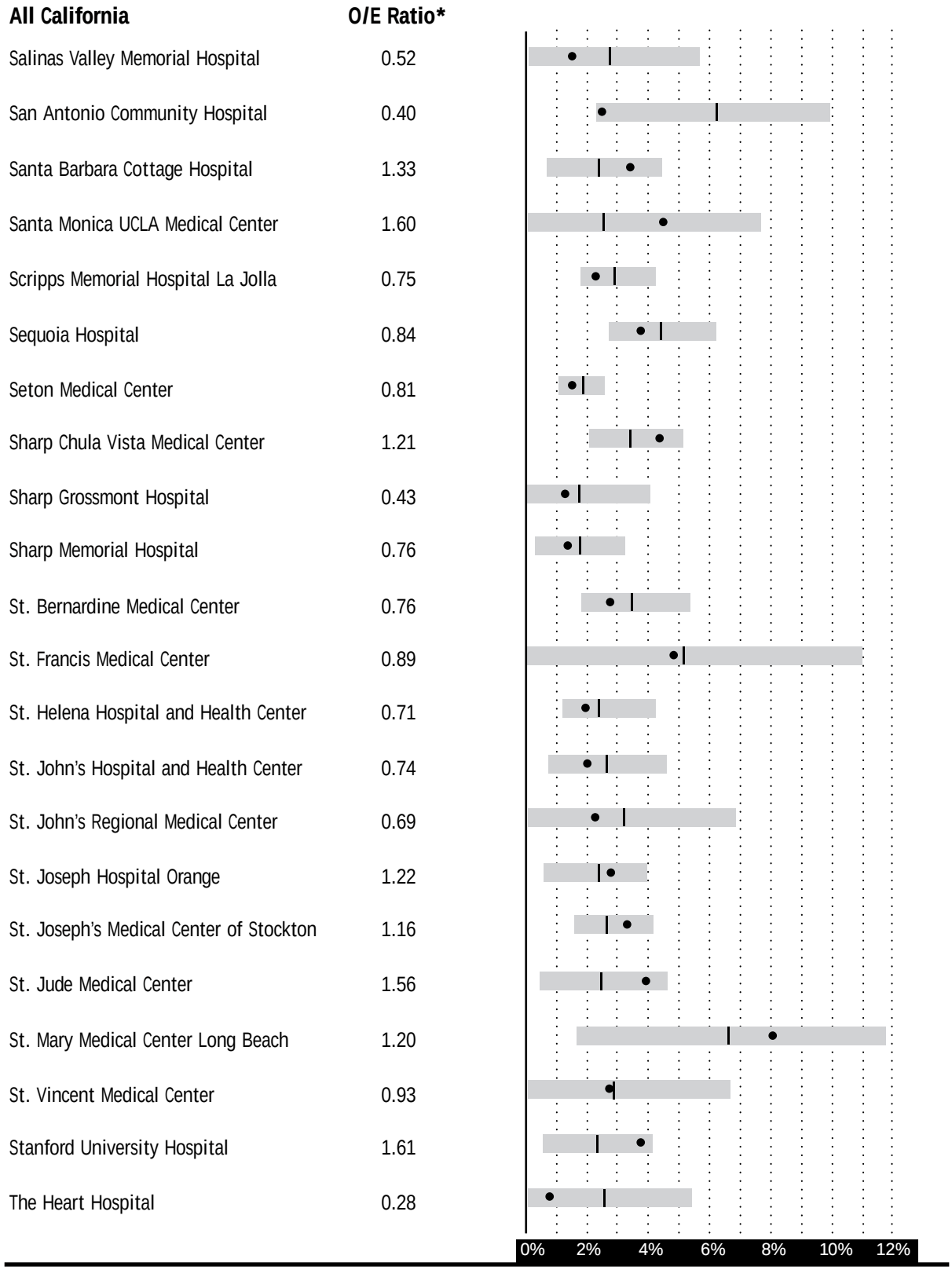
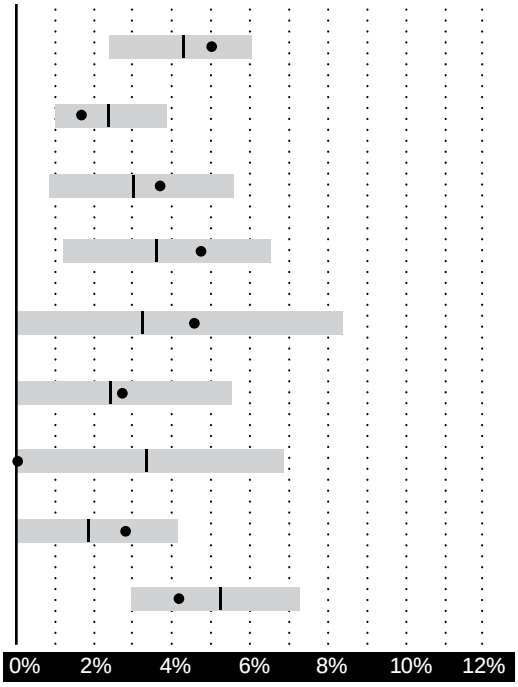


Figure 2 *(cont.)*

COMPARISON OF OBSERVED TO EXPECTED MORTALITY RATE, 1997 – 1998 (in Alphabetical Order by Performance Rating)

Hospitals Performing No Different Than Expected

All California	O/E Ratio*
Torrance Medical Center	1.20
Tri–City Medical Center	0.68
UCLA Medical Center	1.15
UC San Diego University Medical Center (Thornton and Hillcrest)	1.22
UCSF/Mt. Zion University Medical Center	1.43
University of California Davis Medical Center	1.23
University of California Irvine Medical Center	0.00
USC University Hospital	1.46
Washington Hospital Fremont	0.82

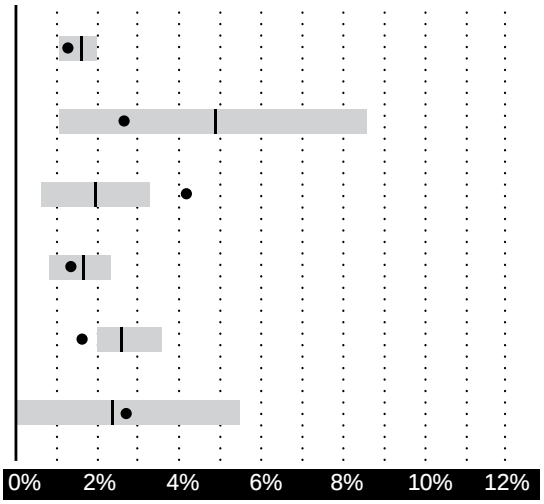


- • Observed Mortality Rate
- | Expected Mortality Rate
- ▒ Range of Expected Mortality Rate (95% Confidence Level)
- ▼ Observed Mortality Rate Significantly Worse than Expected
- ★ Observed Mortality Rate Significantly Better than Expected

*Observed to Expected Events Ratio

Figure 3 *(cont.)* **COMPARISON OF OBSERVED TO EXPECTED MORTALITY RATE, 1997 – 1998 (in Alphabetical Order by Geographic Region)**

Sacramento Valley and Northern California Region	O/E Ratio*
Mercy General Hospital	0.83
Mercy Medical Center—Redding	0.55
▼ Mercy San Juan Hospital	2.15
Redding Medical Center	0.86
★ Sutter Memorial Hospital	0.59
University of California Davis Medical Center	1.23

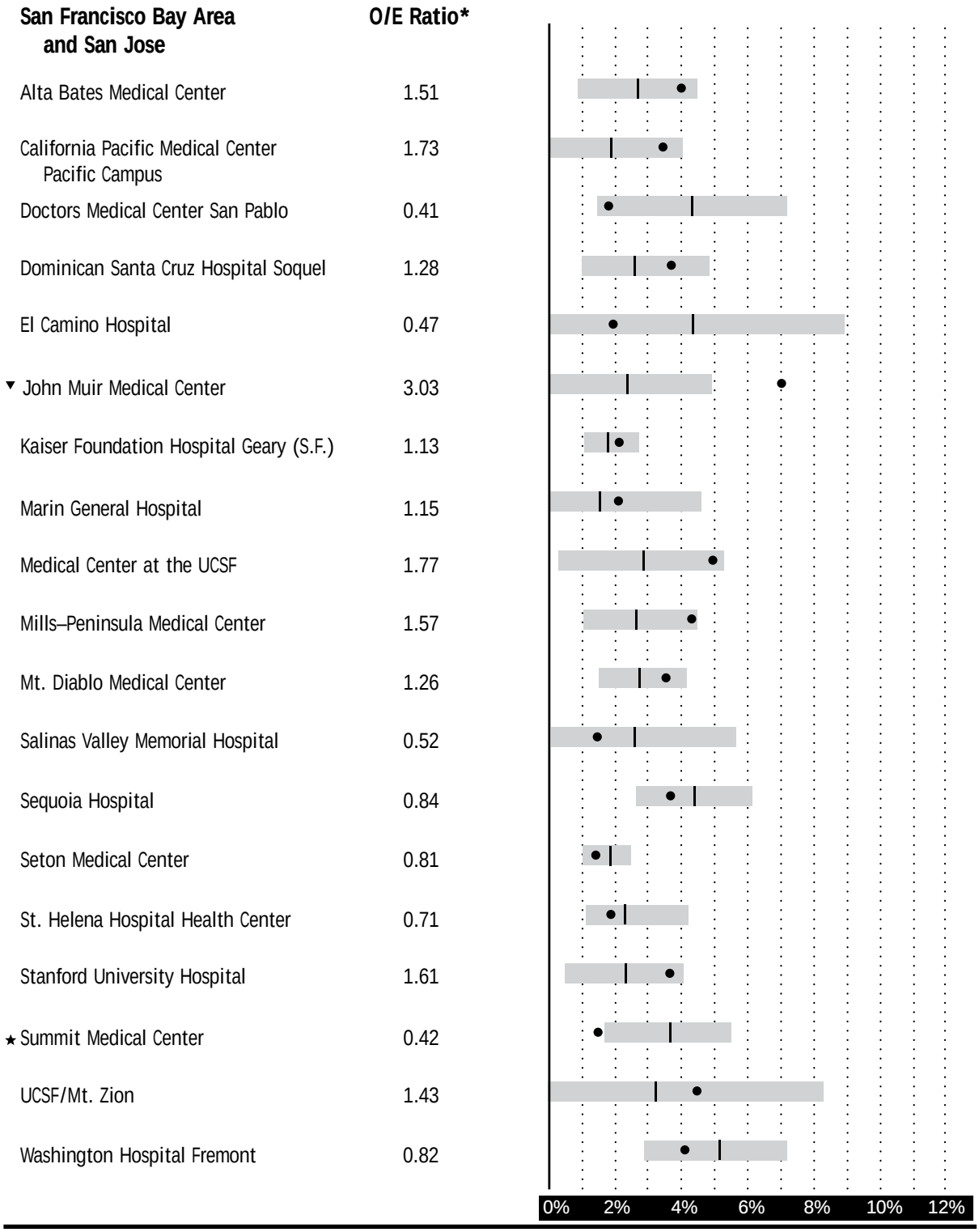


- • Observed Mortality Rate
- | Expected Mortality Rate
- Range of Expected Mortality Rate (95% Confidence Level)
- ▼ Observed Mortality Rate Significantly Worse than Expected
- ★ Observed Mortality Rate Significantly Better than Expected

*Observed to Expected Events Ratio

NOTE: The following hospitals in this region declined to participate: N.T. Enloe Medical Center—Esplanade Campus

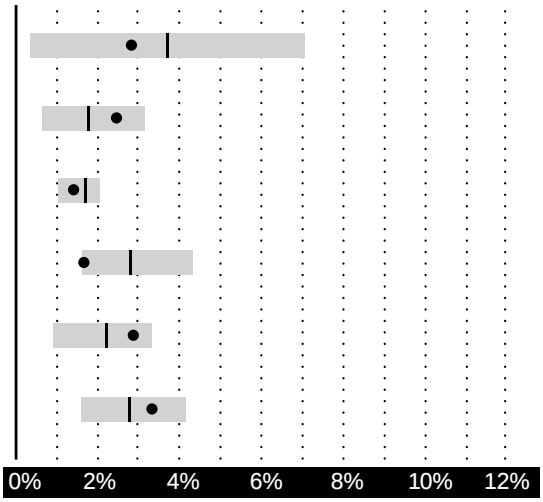
Figure 3 *(cont.)* **COMPARISON OF OBSERVED TO EXPECTED MORTALITY RATE, 1997 – 1998 (in Alphabetical Order by Geographic Region)**



NOTE: The following hospitals in this region declined to participate: Columbia San Jose Medical Center, O'Connor Hospital, Queen of the Valley Hospital—Napa, Santa Clara Valley Medical Center, Santa Rosa Memorial Hospital, St. Mary's Medical Center—San Francisco, Columbia Good Samaritan Hospital

Figure 3 *(cont.)* **COMPARISON OF OBSERVED TO EXPECTED MORTALITY RATE, 1997 – 1998 (in Alphabetical Order by Geographic Region)**

Central California	O/E Ratio*
Dameron Hospital	0.76
Doctors Medical Center Modesto	1.34
Kaiser Foundation Hospital Sunset (L.A.)	0.82
Kaweah Delta District Hospital	0.55
Memorial Hospital Modesto	1.39
St. Joseph's Medical Center of Stockton	1.16

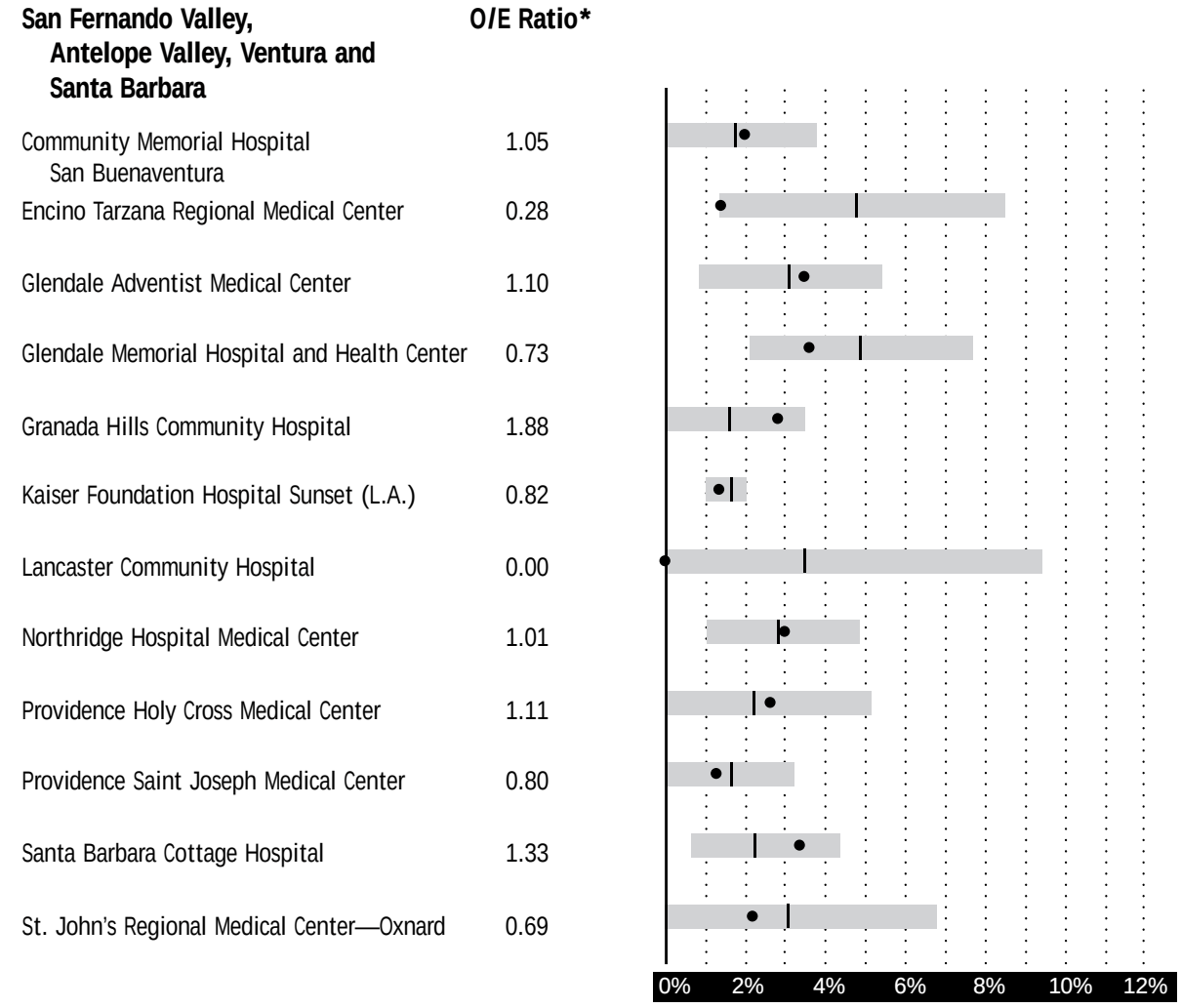


- • Observed Mortality Rate
- | Expected Mortality Rate
- Range of Expected Mortality Rate (95% Confidence Level)
- ▼ Observed Mortality Rate Significantly Worse than Expected
- ★ Observed Mortality Rate Significantly Better than Expected

*Observed to Expected Events Ratio

NOTE: The following hospitals in this region declined to participate: Bakersfield Memorial Hospital, Fresno Community Hospital and Medical Center, San Joaquin Community Hospital, St. Agnes Medical Center

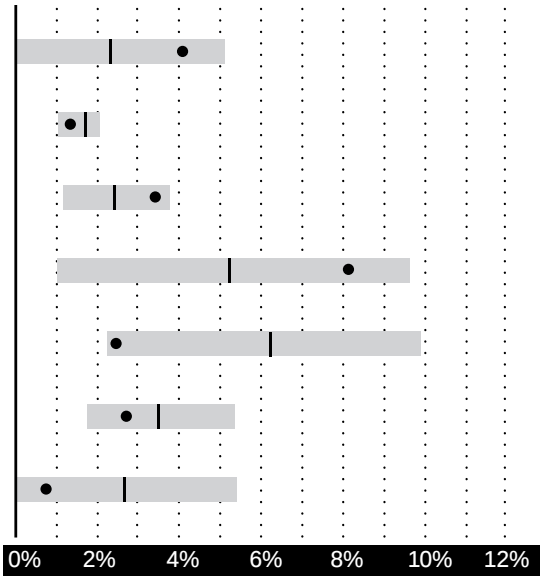
Figure 3 *(cont.)* **COMPARISON OF OBSERVED TO EXPECTED MORTALITY RATE, 1997 – 1998 (in Alphabetical Order by Geographic Region)**



NOTE: The following hospitals in this region declined to participate: Antelope Valley Hospital Medical Center, Columbia Los Robles Hospital Medical Center, Columbia West Hills Medical Center, French Hospital—San Luis Obispo, Huntington Memorial Hospital, Marian Medical Center, Valley Presbyterian Hospital

Figure 3 *(cont.)* **COMPARISON OF OBSERVED TO EXPECTED MORTALITY RATE, 1997 – 1998 (in Alphabetical Order by Geographic Region)**

Inland Empire, Riverside, and San Bernadino	O/E Ratio*
Desert Regional Medical Center	1.72
Kaiser Foundation Hospital Sunset (L.A.)	0.82
Pomona Valley Hospital Medical Center	1.37
Riverside Community Hospital	1.53
San Antonio Community Hospital	0.40
St. Bernardine Medical Center	0.76
The Heart Hospital, Inc.	0.28

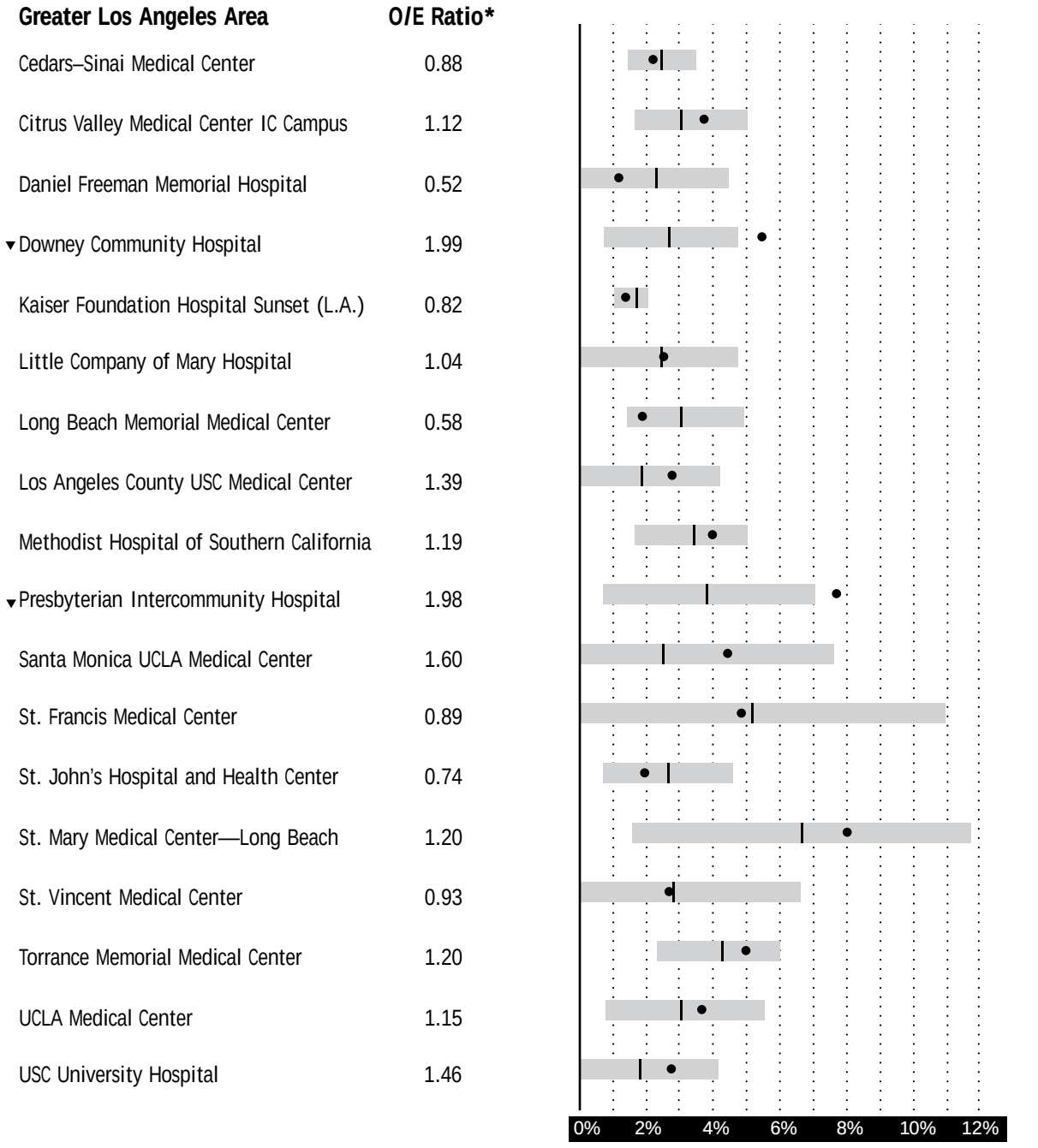


- Observed Mortality Rate
- Expected Mortality Rate
- Range of Expected Mortality Rate (95% Confidence Level)
- ▼ Observed Mortality Rate Significantly Worse than Expected
- ★ Observed Mortality Rate Significantly Better than Expected

*Observed to Expected Events Ratio

NOTE: The following hospitals in this region declined to participate: Eisenhower Medical Center, Loma Linda University Medical Center, St. Mary Regional Medical Center—Apple Valley

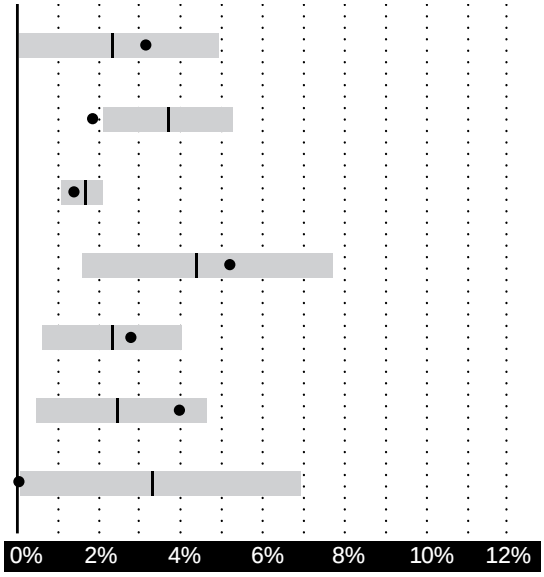
Figure 3 *(cont.)* **COMPARISON OF OBSERVED TO EXPECTED MORTALITY RATE, 1997 – 1998 (in Alphabetical Order by Geographic Region)**



NOTE: The following hospitals in this region declined to participate: Beverly Hospital, Brotman Medical Center, Centinela Hospital Medical Center, Garfield Medical Center, Hospital of the Good Samaritan, Lakewood Regional Medical Center, Long Beach Community Medical Center, Los Angeles County Harbor—UCLA Medical Center, White Memorial Medical Center

Figure 3 *(cont.)* **COMPARISON OF OBSERVED TO EXPECTED MORTALITY RATE, 1997 – 1998 (in Alphabetical Order by Geographic Region)**

Orange County	O/E Ratio*
Anaheim Memorial Medical Center	1.30
★ Hoag Memorial Hospital Presbyterian	0.50
Kaiser Foundation Hospital Sunset (L.A.)	0.82
Saddleback Memorial Medical Center	1.12
St. Joseph Hospital Orange	1.22
St. Jude Medical Center	1.56
University of California Irvine Medical Center	0.00



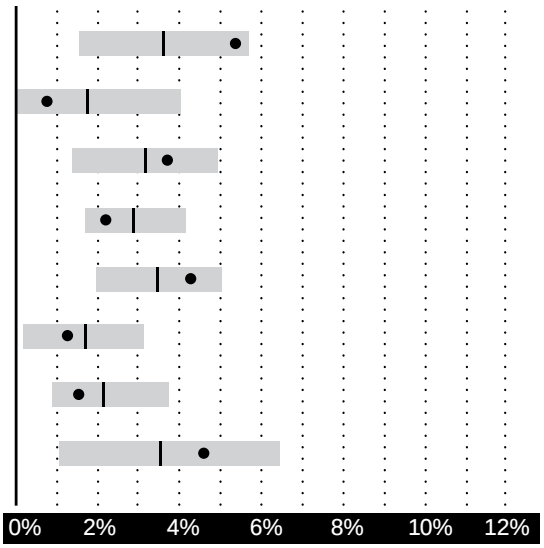
- • Observed Mortality Rate
- | Expected Mortality Rate
- Range of Expected Mortality Rate (95% Confidence Level)
- ▼ Observed Mortality Rate Significantly Worse than Expected
- ★ Observed Mortality Rate Significantly Better than Expected

*Observed to Expected Events Ratio

NOTE: The following hospitals in this region declined to participate: Fountain Valley Regional Hospital and Medical Center—Euclid, Mission Hospital Regional Medical Center, West Anaheim Medical Center, Western Medical Center—Anaheim, Western Medical Center—Santa Ana

Figure 3 *(cont.)* **COMPARISON OF OBSERVED TO EXPECTED MORTALITY RATE, 1997 – 1998 (in Alphabetical Order by Geographic Region)**

San Diego Region	O/E Ratio*
Alvarado Hospital Medical Center	1.49
Sharp Grossmont Hospital	0.43
Palomar Medical Center	1.17
Scripps Memorial Hospital La Jolla	0.75
Sharp Chula Vista Medical Center	1.21
Sharp Memorial Hospital	0.76
Tri–City Medical Center	0.68
UC San Diego University Medical Center (Thornton and Hillcrest)	1.22



- • Observed Mortality Rate
- | Expected Mortality Rate
- Range of Expected Mortality Rate (95% Confidence Level)
- ▼ Observed Mortality Rate Significantly Worse than Expected
- ★ Observed Mortality Rate Significantly Better than Expected

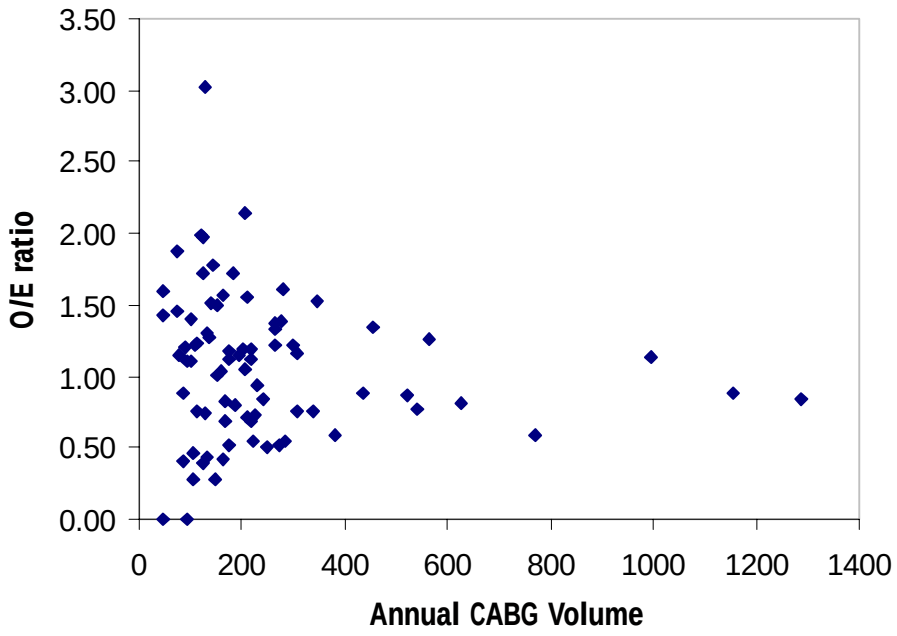
*Observed to Expected Events Ratio

NOTE: The following hospitals in this region declined to participate: Green Hospital of Scripps Clinic, Scripps Mercy Hospital

VII. HOSPITAL VOLUME AND CORONARY ARTERY BYPASS GRAFT SURGERY OUTCOMES

This report began with the observation that only 50 out of 118 California hospitals perform more than 200 CABG surgeries annually, the minimum number recommended by the American College of Cardiology. We can use the results in the preceding section to address the question of whether the volume of CABG surgeries at the hospital level is related to good or bad outcomes. Figure 4 displays a plot that shows the relationship between annual CABG volume and average hospital outcomes, as measured by the O/E ratio. Each dot in Figure 4 identifies a single hospital. For example, the dot near the upper left corner of the figure describes a hospital whose annual volume was 129 CABG cases per year for the 1997–1998 period, with an O/E ratio of slightly above 3.0. The right-most dot in the figure describes a hospital that averaged 1,286 cases per year and exhibits an O/E ratio of 0.86.

Figure 4: Relationship Between CABG Volume and Hospital Outcomes



A regression line through these points is almost flat (it has a very slight negative slope, but that slope is not statistically significantly different from zero), indicating that for the hospitals that submitted their data to CCMRP, there appears to be no overall relationship between annual volume and risk–adjusted outcome. However, it is clear that lower–volume hospitals exhibit highly variable performance. Both the lowest and the highest risk–adjusted outcomes can be observed among low–volume hospitals, although in nearly all cases the low volumes make

those outcomes statistically indistinguishable from an O/E of 1.0 (i.e., given wide confidence intervals around the expected mortality rate). In contrast, there is much less variability among higher–volume hospitals. It is possible that with future data and analysis the lowest statistically valid O/E ratio will occur in a low volume hospital; however, it will take several additional years to accumulate enough cases to validly characterize O/E ratios in low volume hospitals. While the lowest O/E ratios can be found among low–volume hospitals, none of the highest volume hospitals have a poor O/E ratio.

VIII. SUMMARY OF TECHNICAL CONCLUSIONS

The following key conclusions can be drawn from the analysis of the 1997–1998 CABG data submitted by California hospitals:

- Raw unadjusted mortality rates give a false impression of a hospital's relative performance, reinforcing the importance of risk–adjustment in making comparisons across hospitals.
- There is wide variation among California hospitals in their mortality rates for isolated coronary artery bypass graft surgery, even after adjusting for differences in patient severity.
- The high degree of agreement between the actual and predicted number of deaths (as discussed in the **Technical Methods** section, Appendix F) underscores that hospitals should not exclude high–risk patients from appropriate CABG surgeries to improve their risk–adjusted performance scores.
- An examination of the relationship between volume of CABG procedures and outcome finds large variation in the performance results of small-volume hospitals and small variation in the performance results of large-volume hospitals.

One caveat to note is that because CCMRP did not have data from the 38 non-participating hospitals, direct comparison of risk–adjusted mortality rates is not possible. However, an examination of OSHPD hospital discharge data shows that the aggregated raw or unadjusted mortality rates for participating hospitals are essentially identical to those of non–participating hospitals. On average, participating hospitals performed more CABG surgeries than non–participating hospitals (250 per year vs. 209 per year).

One year's results—especially among hospitals with small annual volumes of CABG surgeries—are not sufficient for drawing definitive conclusions about the performance of any given hospital. It will be important to evaluate the performance of hospitals over multiple years to determine whether there is a consistent pattern of performance, either good or bad.

PBGH and OSHPD wish to thank each of the 79 hospitals that volunteered to participate and publicly report their risk–adjusted mortality rates for the 1997-1998 data collection period. It is important to recognize that, regardless of any individual hospital's performance results, participation in CCMRP represents a significant commitment to quality measurement and improvement by each of the participating hospitals.

IX. ADDITIONAL RESOURCES

CCMRP will disseminate the results of this study in a variety of ways. PBGH and OSHPD will post the Technical and Summary Reports on their organizational websites (www.pbgh.org and www.oshpd.state.ca.us). PBGH will post the hospital–specific results of the CABG study on its ***California Consumer HealthScope*** website (www.healthscope.org) a public source of information on health care quality for consumers to use to make more informed health care choices.

PBGH and OSHPD are currently collecting the 1999 data from hospitals and expect to produce a second public report in late Fall 2001. California hospitals that do not participate in CCMRP are welcome to join at any time. For more information about training, software, policy, or other issues, please call Dr. Cheryl Damberg of PBGH (310.396.7036) or Mary MacDonald of OSHPD (916.322.9137).

APPENDICES

APPENDIX A: DEFINITIONS AND INSTRUCTIONS FOR CCMRP DATA SUBMISSIONS

Data Elements	STS Definitions	CCMRP Comments, Modifications, and Examples
1. Date of Surgery	MM–dd–yy.	
2. Gender	Male, female.	
3. Date of Birth	MM–dd–yy.	
4. Race/Ethnicity	Caucasian, Black, Hispanic, Asian, Native American, or other.	
5. Insurer–Payment Source	Primary payer: Medicare, Medicaid, private/corporate, CHAMPUS, or uninsured.	
6. Patient's Zip Code		
7. Height	Centimeters.	
8. Weight	Kilograms.	
9. Pre–operative Creatinine Level	mg/dl. Serum creatinine at time of surgery	The STS form asks for the "highest creatinine" while the *STS Terms and Definitions* guide asks for the most recent pre–operative creatinine. Please follow the guide, i.e., code the most recent pre–operative value. Note also that beginning 1/1/99, the STS will collect this data element for all cases.
10. Hypertension	Blood pressure exceeding 140/90 mm Hg or a history of high blood pressure, or the need for anti–hypertensive medications.	Beginning 1/1/99, the STS proposes to change this definition to: 1. Documented history of HTN diagnosed and treated with medication, diet and/or exercise. 2. BP $\geq$140/90 on 2 occasions. 3. Normotensive but currently on antihypertensive medication.
11. Dialysis	Hemodialysis or peritoneal dialysis.	Check this box if the patient is *currently* on dialysis, not if the patient has ever been on dialysis. This is consistent with the proposed STS definition.
12. Diabetes	A history of diabetes, regardless of duration of disease or need for anti–diabetic agents.	Note that this is a very liberal definition of diabetes.

APPENDIX A: DEFINITIONS AND INSTRUCTIONS FOR CCMRP DATA SUBMISSIONS

Data Elements	STS Definitions	CCMRP Comments, Modifications, and Examples
13. Peripheral Vascular Disease	A history of aneurysm and/or occlusive vascular disease with or without previous extra–cardiac vascular surgery.	As of 1/1/99, the STS proposes to change this definition to: "The patient has PVD, as indicated by any or all of: claudication either with exertion or rest; amputation for arterial insufficiency; aorto–iliac occlusive disease reconstruction; peripheral vascular bypass surgery, angioplasty, stent documented AAA, AAA repair or stent; documented positive non–invasive testing." Cerebrovascular disease is not included in peripheral vascular disease, since it has its own data element.
14. Cerebrovascular Disease	Any TIA, RIND (Reversable Ischemic Neurologic Deficit), CVA, or history of cerebrovascular surgery.	As of 1/1/99, the STS proposes to change this definition to: "The patient has a documented history of: CVA (symptoms > 72 hrs after onset); RIND (recovery with 72 hrs); TIA (return within 24 hrs); unresponsive coma > 24 hrs; non–invasive carotid test with > 75% occlusion."
15. Ventricular Arrhythmia	Abnormal rapid ventricular rhythm causing hemodynamic collapse (tachycardia) or diffuse chaotic ventricular depolarization unable to produce an effective blood pressure.	Ventricular arrhythmia does NOT refer to frequent PVC's (premature ventricular beats), bigeminy, or non–sustained ventricular tachycardia. Note that as of 1/1/99, the STS proposes to change this definition to: "Within two weeks of the procedure, clinical documentation of sustained VT or VF requiring cardioversion and/or IV antiarrhythmics."
16. Myocardial Infarction	A patient is considered to have had a myocardial infarction if there is documented evidence of a transmural infarction defined by the appearance of a new Q wave in two or more contiguous leads on ECG, or subendo–cardial infarction (non Q wave), which is considered present in a patient having clinical, angiographic, electro–cardiographic, and/or laboratory isoenzyme evidence of myocardial necrosis with an ECG showing no new Q waves.	Check this box if the patient has ever had an MI. For STS users, we will collect the data element "MI and not the element "MI Type." Note that as of 1/1/99, the STS proposes to change this definition to: 1. "Patient hospitalized for an MI documented in the medical record. 2. Two of four criteria are necessary: prolonged (> 20 min) "typical" chest pain not relieved by rest and/or nitrates; enzyme level elevation; CK–MB > 5% or total CPK CK greater than 2x normal; LDH subtype 1 > LCH subtype 2; troponin > 0.2 ug/ml; new wall motion abnormalities; ; serial ECG (at least two) showing changes from baseline or serially in ST–T and/or Q waves that are 0.03 seconds in width and/or > or + one third of the total QRS complex in two or more contiguous leads."
17. Date/Time of Most Recent MI	STS data element "MI When: < 6 hrs., < 24 hrs., 1–7 days, 7–21 days, >21 days" refers to the last documented infarction.	For STS users, we will collect the variable "MI When." For users of CCMRP , we will collect date of MI and calculate the interval from MI to surgery.

APPENDIX A: DEFINITIONS AND INSTRUCTIONS FOR CCMRP DATA SUBMISSIONS

Data Elements	STS Definitions	CCMRP Comments, Modifications, and Examples
18. Number of Prior Cardiac Operations Requiring Cardiopulmonary Bypass	Prior to this operation being recorded, which may be during this admission, how many cardiac surgical operations were performed on this patient utilizing cardiopulmonary bypass.	Note that we do not code re–dos on the same admission separately. In addition, we may update this definition later to reflect "minimally invasive" procedures done "off–pump."
19. Date of Most Recent Cardiac Operation	This is the definition for the STS variable "Date of most recent CV intervention": Date patient having undergone any previous cardiac procedure, which may be during current admission. For STS users, either record the date of the most recent cardiac operation in this field or, if you have added a customized field for this data element, record it there.	Enter the date of the most recent cardiac operation (CABG, valve surgery, intracardiac repair) Do *not* record the date of the prior PTCA's, non–cardiac vascular surgeries, pacemaker or defibrillator implantations, or other interventions. Note that there is some ambiguity on the STS data collection form, which asks for "Previous CV intervention: most recent" while the STS Terms and Definitions makes it clearer that cardiac procedures, and not vascular procedures, are the real target. In addition, the STS form makes it difficult to tell whether the most recent CV intervention was a bypass, a PTCA, or some other procedure since one can "check off" more than one box, and the date of the last catherterization is captured under "Catheterization Data."
20. Number of Prior PTCAs	Total number of previous PTCA/ Atherectomy procedures prior to the cardiac surgical procedure.	The number of PTCA's refers to the number of separate procedures (including any performed during the current hospitalization), NOT the number of vessels dilated.
21. PTCA/Atherectomy during Same Admission as Surgery	Was the interventional cardiologic procedure performed during the same in–patient admission as the current operation? Yes/No.	
22. PTCA to Surgery Time Interval	<6 hrs., >6 hrs.	If PTCA occurred during this admission. Note beginning 1/1/99, the STS proposes to rename this data element "Unplanned CABG" and to collect the date and time of the last intervention, and date and time of the last surgical intervention.

APPENDIX A: DEFINITIONS AND INSTRUCTIONS FOR CCMRP DATA SUBMISSIONS

Data Elements	STS Definitions	CCMRP Comments, Modifications, and Examples
23. Chronic Obstructive Pulmonary Disease	A patient who requires pharmacologic therapy for the treatment of chronic pulmonary compromise, or a patient who has a FEV1 < 75% of predicted value.	After 1/1/99, the STS proposes to change the name of this data element to "Chronic Lung Disease," and to replace the existing definition with: "Patient with clinical documentation of any of the following: pharmacologic Rx (inhalers, theophylline/aminophylline, steroids); FEV1 < 75%; RA pO2 < 60; RA pCO2 > 50." Patients do NOT have COPD merely on the basis on a heavy smoking history or being labeled "COPD" in the chart without other documentation.
24. Congestive Heart Failure	At least three of the following: 1) presence of dyspnea; 2) rales thought to represent pulmonar congestion; 3) peripheral edema; 4) cardiomegaly on chest x–ray; 5) chest x–ray compatible with interstitial edema.	Note that as of 1/1/99, the STS proposes to change this definition to: 1. "Within 2 weeks prior to procedure. Physician Dx of CHF is made. 2. Within 2 weeks prior to procedure, one or more are present: PND; dyspnea on exertion due to heart failure; pulmonary congestion on CXR. 3. Pedal edema or dyspnea alone are not diagnostic. 4. Pt should have received diuretics or digoxin." Note also that NYHA function class (below) refers only to the severity of the patient's heart failure at the time of surgery, and not to the severity of heart failure in the past.
25. Angina	Yes/No.	Check this box if the patient has ever had angina.
26. Unstable Angina	Stable: Angina which is controlled by oral or transcutaneous medication. Unstable: The presence of on–going refractory ischemia that requires hospitalization in an intensive care unit and use of intravenous nitrate therapy for control.	The current STS definition of unstable angina requires hospitalization in an ICU and treatment with intravenous nitroglycerin. However, beginning 1/1/99, the STS proposes to replace this with "Angina at rest (>20 min); or new onset (<2 months); or CCS Class III angina; or recent acceleration in pattern and increase of one CCS Class to CCS III; or variant angina; or non–Q MI; or post–infarction angina (>24 hrs); or 'Clinical Classification' (IV nitrates (or equivalent), IV heparin (or equivalent), and telemetry monitoring). Patients with myocardial infarctions who present with angina should have their angina type and CCS Class coded in addition to their myocardial infarction. Thus, a patient presenting with angina at rest who is subsequently diagnosed with a myocardial infarction would have angina=yes, type=unstable, CCS=Class IV, MI=yes.

Data Elements	STS Definitions	CCMRP Comments, Modifications, and Examples
27. NYHA (New York Heart Association) Congestive Heart Failure Functional Class	**I=** Patients with cardiac disease but without resulting limitation of physical activity. Ordinary physical activity does not cause undue fatigue, palpitation, dyspnea, or angina. **II=** Patients with cardiac disease resulting in slight limitation of physical activity. They are comfortable at rest. Ordinary physical activity results in fatigue, palpitations, dyspnea, or anginal pain. **III=** Patients with cardiac disease resulting in marked limitation of physical activity. They are comfortable at rest. Less than ordinary physical activity results in fatigue, palpitations, dyspnea, or anginal pain. **IV=** Patients with cardiac disease resulting in inability to carry on any physical activity without discomfort. Symptoms of cardiac insufficiency or of the anginal syndrome may be present even at rest. If any physical activity is undertaken, discomfort is increased. If this information is not defined in the patient's chart, the minimum data requirement is the notation of a NYHA status to be calculated by the data manager using the patient's recorded history and the detail definition of the three scales. Asymptomatic patient should be classified as a NYHA Class I. NYHA class should be utilized to determine functional class secondary to heart failure.	NYHA class refers to the severity of recent heart failure (within two weeks of surgery) and not to past episodes of CHF. If a patient has a history of heart failure but is well compensated with no or only minimal symptoms at the time of surgery, the patient is coded as NYHA=Class I, CHF=yes.

APPENDIX A: DEFINITIONS AND INSTRUCTIONS FOR CCMRP DATA SUBMISSIONS

Data Elements	STS Definitions	CCMRP Comments, Modifications, and Examples
28. CCS (Canadian Cardiovascular Society) Angina Class	**I=** Ordinary physical activity does not cause angina. Angina may occur with strenuous, rapid or prolonged exertion at work or recreation. **II=** There is slight limitation of ordinary activity. Angina may occur with walking or climbing stairs rapidly, walking uphill, walking or stair climbing after meals or in the cold, in the wind, or under emotional stress, or walking more than two blocks on the level, and climbing more than one flight of stairs at normal pace under normal conditions. **III=** There is marked limitation of ordinary physical activity. Angina may occur after walking one or two blocks on the level or climbing one flight of stairs under normal conditions at a normal pace. **IV=** There is inability to carry on any physical activity without discomfort; angina may be present at rest.	CCS angina class refers to the highest recent class (in the two weeks before surgery). Patients who have never had angina are coded as angina=no, CCS=Class I. Class I also refers to patients who have had angina in the past but are now *asymptomatic* and to patients who have symptoms only with strenuous activity (both would be angina=yes, CCS=Class I). Patients with angina at rest or with even minimal activity are Class IV (this includes many patients with unstable angina). Classify angina when present even for patients with myocardial infarctions. Thus, code a patient presenting with chest pain at rest and a myocardial infarction as angina=yes, angina unstable=yes, CCS=class IV, MI=yes.

APPENDIX A: DEFINITIONS AND INSTRUCTIONS FOR CCMRP DATA SUBMISSIONS

Data Elements	STS Definitions	CCMRP Comments, Modifications, and Examples
29. Acuity (Elective, Urgent, Emergent, or Salvage)	Refers to the severity of the patient's condition in the immediate pre–operative time period. An elective operation is one that is performed on a patient with cardiac function that has been stable in the days or weeks prior to operation. Elective cases are usually scheduled at least one day prior to the surgical procedure. An urgent operation is one in which surgery is required within 24 hours in order to minimize the chance of further clinical deterioration. Typical patients include those with sudden, worsening chest pain and/or congestive heart failure, life–threatening coronary vascular anatomy, or those who are symptomatic at rest. Delay in operation is necessitated only by attempts to improve the patient's condition, availability of a spouse or parent for informed consent, availability of blood products, or the availability of results of essential laboratory procedures or tests. An urgent status is not merited by left main disease alone, use of heparin infusions, or purely administrative considerations. Patients requiring emergency operations will have ongoing, refractory, unrelenting cardiac compromise, with or without hemodynamic instability, and not responsive to any form of therapy except cardiac surgery. An emergency operation is one in which there should be no delay in providing operative intervention. Emergent/salvage: Patient undergoing CPR en route to the operating room or prior to induction of anesthesia.	Status refers to the patient's condition immediately before surgery; it should not reflect instability which occurs after the induction of anesthesia or the operative outcome. Status does not assess operative risk but rather how expediently surgery must be performed. Thus, some elective patients may be at higher risk than urgent patients; for example, an elderly patient with an ejection fraction of 20% and COPD operated on electively compared to a young patient with a normal ejection fraction who has ongoing unstable angina. Elective surgeries are performed on patients whose cardiac function has been stable. They are usually scheduled at least one day prior to surgery, and the clinical picture allows discharge from the hospital with readmission for surgery later. A surgery is elective even if the patient was operated on during a hospitalization for an acute coronary syndrome if he or she *could have been discharged* to have surgery at a later date. Elective patients are at a low risk for morbidity or death outside of the hospital given good medical management and restricted activities. Urgent surgeries are performed on patients whose medical condition requires continuous hospitalization prior to CABG. The patients may be operated on in the next available surgical suite but would not necessarily take precedence over an elective case and, *clarifying the STS definition,* could wait more than 24 hours, possibly several days. A critical feature that distinguishes urgent from elective patients is that urgent patients *cannot be safely discharged* prior to their CABG, but they can safely await CABG in the hospital. An intra–aortic balloon pump or IV nitroglycerin may be part of treatment. Emergent surgeries are performed on patients whose condition dictates that the surgery be performed within several hours to prevent morbidity or death. These cases should take precedence over an elective case, cause a new operating room to be opened, or be done at night or on a weekend if necessary. A critical feature which distinguishes emergent from urgent patients is that emergent patients *cannot safely delay CABG even while they are in the hospital*. Salvage surgeries are performed on a patient undergoing CPR en route to operating room or in the operating room prior to induction of anesthesia.

APPENDIX A: DEFINITIONS AND INSTRUCTIONS FOR CCMRP DATA SUBMISSIONS

Data Elements	STS Definitions	CCMRP Comments, Modifications, and Examples
30. Ejection Fraction (5 to 90%)		Most recent prior to surgery.
31. Method for Measuring Ejection Fraction (LV Gram, Radionuclide, or Echocardiogram)		Ejection fraction (EF) is determined by one of the following methods (in order of preference): Left ventriculogram, radionuclide scan, or echocardiogram. EF is an important predictor of risk. Make every effort to obtain it when available. Use the last determination of EF prior to surgery. When an official report gives both a calculated EF and an estimated EF, use the calculated value. The EF must be obtained from the official report of one of the above three studies; do not use an "estimate," which, in contrast to the STS system, will be considered the same as a missing value. If a range of EF's is given, enter the mean value (e.g. for "30 to 35%," enter "32" –the STS system has no space for 32.5). If the EF or "left ventricular function" is described qualitatively, enter as follows: normal = 65%, mildly reduced = 50%, moderately reduced = 35%, and severely reduced = 20%. A transesophageal echocardiogram (TEE) done during surgery should not be used as a source for either mitral regurgitation or EF, unless it is the only available study, because operative conditions can artifactually alter both mitral regurgitation and ejection fraction.
32. Left Main Stenosis (%)		Actual percent

APPENDIX A: DEFINITIONS AND INSTRUCTIONS FOR CCMRP DATA SUBMISSIONS

Data Elements	STS Definitions	CCMRP Comments, Modifications, and Examples
33. Coronary Disease – Number of Vessels	None, single, double, triple. The number of major (LAD system, Cx system, Right system) coronary vessels with > 50% narrowing in any angiographic view. Enter none if only left main disease.	The number of vessels refers to the number of major coronary arteries that are diseased. Consider a major coronary artery as diseased if it or one of its first order branches has a >50% stenosis. The three major coronary arteries and their first order branches are 1) the left anterior descending (LAD) with its branches the diagonals; 2) the circumflex (Cx) with its branches the obtuse marginals (OM's) or circumflex marginals; and 3) the right coronary artery (RCA) with its branch the posterior descending artery (PDA). Consider left main disease separately from the LAD and circumflex. Thus, code the "number of vessels" as "none" for a patient who has stenosis of the left main but not the LAD, circumflex, or RCA. When the posterior descending artery (PDA) is supplied by the circumflex (i.e., when the circumflex instead of the right coronary artery is dominant), count the PDA (but NOT the non–dominant RCA) as a major vessel. Thus, a patient with stenoses of the LAD, an obtuse marginal branch off of the circumflex, and the PDA off of the circumflex would be coded as having triple vessel disease (even if the non–dominant right coronary is normal). When a large ramus medianus branch supplies part of the LAD or circumflex distribution, count the ramus as a first order branch of one of those vessels. Thus, a patient with stenoses of the ramus, circumflex, and RCA may be counted as 3 vessel disease (however, do NOT count 3 vessel disease if disease involves the LAD, circumflex, and ramus but not a dominant RCA). NOTE: the number of major arteries counted as diseased may differ from the number of bypass grafts placed (e.g., a graft may be placed to a vessel with < 50% stenoses or two grafts to the LAD and diagonal even though both are part of a single major vessel).
34. Mitral Insufficiency	Is there evidence of regurgitation: 0 = none, 1 = trivial, 2 = mild, 3 = moderate, 4 = severe.	Mitral insufficiency (or regurgitation) should be determined by (in order of preference) either the echocardiogram or the left ventriculogram. The preferred order for MR favors echocardiogram over left ventriculogram; this is the opposite of the preferred order for ejection fraction. However, either method is adequate and it is not necessary to obtain an echocardiogram in patients already having ventriculograms. If a range of MR is given, enter the higher value (e.g. for "2 to 3" enter "3"). Transesophageal echocardiograms (TEE's) done during surgery should not be used as a source for either MR or EF, because operative hemodynamic conditions can artifactually alter both.
35. Cross Clamp Time	Minutes.	
36. Perfusion Time	Minutes.	
37. IMA (Internal Mammary Artery) Used	Yes/No.	

APPENDIX A: DEFINITIONS AND INSTRUCTIONS FOR CCMRP DATA SUBMISSIONS

Data Elements	STS Definitions	CCMRP Comments, Modifications, and Examples
38. Cardioplegia	Yes/No.	
39. Date of Discharge	MM–dd–yy	
40. Patient Status at Discharge		Note for STS users: CCMRP will collect the data element "Mortality (Yes/No)"
41. Date of Death	MM–dd–yy	If known

Of the above elements, a cardiac surgeon or cardiologist should review the following:

COPD (Yes/No)
NYHA Heart Failure Class (I, II, III, IV)
Unstable Angina (Yes/No)
Status (Elective, Urgent, Emergent, Salvage)
Congestive Heart Failure (Yes/No)
Angina (Yes/No)
CCS Angina Class

APPENDIX B: DESCRIPTIONS OF CABG REPORTING PROGRAMS OPERATED BY OTHER STATES AND ORGANIZATIONS

New York State Department of Health

The New York State Department of Health reports risk–adjusted CABG mortality rates at the hospital and surgeon level. Unlike California, New York limits the number of hospitals that can perform bypass surgery, through its Certificate of Need process. New York State has issued reports encompassing bypass surgery data from 1989–1991, 1992, 1992–1994 and 1996-1998. Additionally, the state has published data on risk–adjusted mortality rates for angioplasty at the hospital level, based on discharges for 1994. Hospitals collect data on patient demographics and clinical characteristics (40 risk factors) and submit the data to the Department of Health for analysis. Data are audited to ensure the quality of information reported into the system and to safeguard against upcoding. The consumer report uses bar charts (showing the mean and confidence interval) to show the number of cases and risk–adjusted outcomes, while the technical reports present results using a numeric format. Results can be viewed at the State's website (www.health.state.ny.us/nydoh/consumer/heart/).

New Jersey Department of Health and Senior Services

In 1997, New Jersey began reporting on risk–adjusted CABG mortality rates, at the hospital and surgeon level, showing data from 1994–1995. Surgeon level data are presented only for those surgeons who performed at least 100 operations over the two–year period. All 13 hospitals in New Jersey that perform cardiac surgery are required to collect and submit information on patient demographics, pre–operative risk factors, complications of surgery, and discharge status. The Peer Review Organization of New Jersey verifies the accuracy of data by comparing a random sample of cases against medical records. The consumer report presents risk–adjusted mortality results using bar charts (mean score and confidence intervals), while the technical report presents results in a numeric format. The guide is available at the Department's website (www.state.nj.us/health).

The Pennsylvania Health Care Cost Containment Council

The Pennsylvania Health Care Cost Containment Council was formed in 1986 and produced its first annual consumer report on coronary artery bypass graft surgery in 1989. The Council collects demographic data, hospital charges, and diagnosis and procedure codes using ICD–9–CM specifications. Data are gathered at the hospital level using the medical record and submitted to the Council on a quarterly basis. The Council contracts with MediQual Systems, Inc., and participating hospitals are required to use MediQual's Atlas Severity of Illness System to obtain patient severity and morbidity information. The Council's report shows the risk–adjusted in–hospital mortality rate by hospital (44 hospitals) and by surgeon for surgeons with a minimum of 30 cases in a year. Pennsylvania also provides statistics on the surgical approach used by each hospital and surgeon. The report includes other indicators of care such as average length of stay, charge per day, and risk–adjusted mortality rate by health plan (payor) and by hospital. The technical report shows a directory of physicians, the hospitals where the physician practices, and the case volume for each surgeon (both the number the

surgeon performs at an individual hospital as well as across all hospitals where the surgeon practices). The consumer report (***Pennsylvania's Guide to Coronary Artery Bypass Graft Surgery, 1994–1995***) presents the data using a bar chart while the technical report presents the results in numeric fashion. Results can be viewed at the Council's website (www.phc4.org).

Cleveland Health Quality Choice

The Greater Cleveland Health Quality Choice Coalition was formed in 1989 to design and develop quality measurement systems; however, this program ceased operations in 1999. The coalition published its first report in 1989. The ***1998 Greater Cleveland Consumer Report on Hospital Performance*** reports on patient satisfaction, general medical outcomes, general surgical outcomes, intensive care outcomes, C–section and VBAC rates, and outcomes by clinical services. Most of the data in the report are not focused on CABG surgery. For the 1998 report, nine hospitals performed bypass surgery. The report shows risk–adjusted in–hospital mortality rates and length of stay by hospital. The consumer report presents information using symbols (arrows) to display observed to expected performance. The technical report presents data using a numeric format. The coalition uses hospital discharge data (administrative data) to prepare its reports. For more information, view the coalition's website (www.cpl.org/CHQC/).

The Veterans Affairs Continuous Improvement in Cardiac Surgery Program (CICSP)

In 1972, the Department of Veterans Affairs (VA) created the Cardiac Surgery Consultant's Committee (CSCC) to improve the quality of cardiac care provided to veterans. The Continuous Improvements in Cardiac Surgery Study (CICSS) emerged in 1987 from the work of this committee. The initiative was re–named The Continuous Improvements in Cardiac Surgery Program (CICSP) in 1993, and since that time it has compared the quality of cardiac care across VA facilities. The program collects and reports a cross–section of risk–adjusted morbidity and mortality rates in a series of six–month time segments, and it also tracks trends over time. There are no minimum volume exclusion criteria, so all cardiac surgeries at all VA hospitals are included in the analysis. Also, if a local hospital provides cardiac care to VA patients through a sub–contractor arrangement, the outcomes from that hospital are added to the analysis. The data for the program are validated through multiple processes; these include built–in quality checks within the computer system which holds the abstracted data, as well as inter–rater reliability checks across abstraction forms. Semi–annually, the risk–adjusted outcome information is distributed in the form of a confidential internal report to the CSCC. Each participating facility receives a blinded copy of each report and its own hospital code identifier. No data are made publicly available to patients/consumers.

APPENDIX C: 1997–1998 CCMRP DATA COLLECTION FORM/TOOL

Patient Name:_____ Surgery Date _____
(for your use only)

Demographics

☐ Male ☐ Female Date of Birth _____

Race/Ethnicity _____ Insurer _____

Patient's Zip Code_____

History

Height _____ cm Weight _____ kg Creatinine prior to surgery _____ mg/dl

☐ Hypertension ☐ Dialysis ☐ Diabetes

☐ Peripheral Vasc Disease ☐ Cerebrovascular Disease ☐ Ventricular Arrhythmia

☐ MI Date of most recent MI _____

No. of prior ops w/ cardio bypass _____ Date most recent cardiac op _____

No. of prior PTCAs _____ ☐ PTCA on current admission PTCA–Surgery Interval _____ hrs.
(If this admission)

A surgeon or cardiologist should review the following:

☐ COPD ☐ CHF NYHA: ☐ I ☐ II ☐ III ☐ IV

☐ Angina ☐ Unstable Angina CCS Class: ☐ I ☐ II ☐ III ☐ IV

Status: ☐ Elective ☐ Urgent ☐ Emergent ☐ Salvage

Catheterization Data:

EF _____% EF measured by: ☐ LV Gram ☐ Radionuclide ☐ Echocardiogram

Left main stenosis _____ %

Coronary disease (stenosis > 50%): ☐ none ☐ single ☐ double ☐ triple

Mitral insufficiency: ☐ none ☐ trivial ☐ mild ☐ moderate ☐ severe

Operative Data Cross clamp time: _____ minutes Perfusion time: _____ minutes

☐ IMA graft ☐ Cardioplegia

Discharge Date of discharge _____ Status at discharge: ☐ alive ☐ dead

Date of death (if known) _____

APPENDIX D: VARIABLES FROM JONES AND COLLEAGUES (1996)*

Information Category	Core Variables	Level 1 Variables	Level 2 Variables
Demographics	• Age • Gender	• Height • Weight	• Race • Educational level • Marital status • Location of residence
Administrative			• Institution where CABG performed • Surgeon responsible for CABG • Payment source
History	• Previous heart operation	• PTCA on current admission • Date of most recent MI • Angina history	• Date of last cardiac operation • Number of previous CABG's • Angina on admission • Number of previous PTCAs • Date of most recent PTCA • Number of previous MIs
Left ventricular function	• Left ventricular ejection fraction		• Left ventricular end–diastolic pressure
Left main disease	• % stenosis of left main coronary artery		
Other cardiac conditions		• Serious ventricular arrhythmias • Congestive heart failure • Mitral regurgitation	
Cardiovascular risk factors		• Diabetes • Cerebrovascular disease • Peripheral vascular disease	• Smoking • Hypertension • Diabetes sequelae
Comorbid conditions		• COPD • Creatinine levels	• Cardiac pacemaker • Refusal of blood products • Substance abuse • Liver disease • Malignancy • Immunosuppressed state
Acuity	• Elective • Urgent • Emergent/ongoing ischemia • Emergent/hemodynamic instability • Emergent/salvage		• Hospital location before operation

* See "Identification of Preoperative Variables Needed for Risk Adjustment of Short–term Mortality after Coronary Artery Bypass Graft Surgery," JACC 28(6): 1478–87.

APPENDIX E: PRINCIPLES OF PARTICIPATION AGREEMENT WITH HOSPITALS

Hospital who signs below (hereinafter referred to as "Hospital") and the California CABG Mortality Reporting Program (hereinafter referred to as "CCMRP"), through the Pacific Business Group on Health (hereinafter referred to as "PBGH") and the Office of Statewide Health Planning and Development (hereinafter referred to as "OSHPD"), propose jointly to undertake the collection, verification, and reporting of pre–operative risk factor and mortality data with regard to isolated coronary artery bypass graft (CABG) procedures.

PBGH and OSHPD established CCMRP, a **voluntary statewide reporting program**, to collect hospital–level performance data on CABG surgeries. PBGH and OSHPD will neither have access to surgeon–identifiable information nor individual patient identifiers.

Hospitals who voluntarily agree to participate are asked to adhere to the principles outlined below, established by PBGH and OSHPD for CCMRP. Hospitals entering into this voluntary agreement may terminate the agreement at any time without cause upon notice to PBGH.

PBGH and OSHPD agree to the following principles:

- While PBGH and OSHPD do not require that Hospital does so, it encourages Hospital to participate in the Society of Thoracic Surgeons cardiac surgery data registry, and has made efforts to coordinate data elements, definitions, and training with the STS.
- PBGH and OSHPD will make available training sessions and training materials to all interested hospital staff on how to collect and code the required data elements. Training sessions and materials will be made available periodically at no cost to attendees. Although attending a training session is optional for a hospital, staff must complete a short test, provided by PBGH and OSHPD, to ensure a minimum level of proficiency in coding.
- PBGH and OSHPD will compile data from all participating hospitals in California. The data will reside at OSHPD. OSHPD will adhere to standard rules of confidentiality on the release of data. The data will be accessible both to hospitals and the public.
- PBGH and OSHPD will clean and edit the data prior to analysis.
- PBGH and OSHPD will conduct periodic auditing of data at hospitals. PBGH and OSHPD will assume the costs of conducting the data audit.
- PBGH and OSHPD will provide participating hospital with risk–adjusted mortality rate data prior to the public release of this information.
- PBGH and OSHPD will make publicly available the risk adjustment model used in the analysis.
- PBGH intends to issue an annual report that defines the risk–adjusted mortality rate for CABG's at participating hospitals. Data will be reported at the hospital level only. PBGH intends to make these reports publicly available.
- PBGH and OSHPD intend to produce a public access database that will be available

through OSHPD.

- If Hospital does not participate in any other database registry and therefore does not have any other software program to collect its data, PBGH and OSHPD will provide free data entry software specifically designed to collect the data elements for CCMRP.

Hospital agrees to the following principles:

- Hospital will provide to PBGH and OSHPD pre–operative risk factor and mortality data on **all** isolated CABG surgeries performed at the hospital.
- Hospital agrees to submit data on a quarterly basis to PBGH and OSHPD no later than 30 days past the end of the reporting quarter. Data are to be submitted on computer diskette according to the specifications outlined. Data submission to CCMRP should not be construed as a replacement for submission of data to any other data registry and if Hospital participates in the Society of Thoracic Surgeons cardiac surgery database registry, it should continue to do so.
- Hospital agrees to remove all surgeon identifiers prior to submitting data to PBGH and OSHPD.
- Hospital agrees to participate in periodic audits of the data which will be conducted by PBGH and OSHPD. Hospital agrees to supply PBGH and OSHPD with requested medical records to verify the accuracy of data. Hospital will assume labor costs to pull requested medical records.
- Hospital agrees to designate a cardiac surgeon for CCMRP who will serve as a liaison for the hospital to PBGH and OSHPD.
- Hospital agrees to supply their own hardware (i.e., computer) for data entry of pre–operative risk factor and mortality data.
- Hospital agrees to allow appropriate personnel (e.g., surgeons, medical records staff, or data managers) to receive training (either in person or by written materials). Hospital agrees to have hospital personnel responsible for data entry complete a test regarding the coding of data in order to assure a minimum standard of data quality.

On behalf of _____ hospital, I agree to the above provisions of participation in CCMRP.

Signed: _____

Name: _____

Title: _____

Address: _____

_____

Phone: _____ FAX: _____

Name of designated cardiac surgeon: _____

_____

_____

(signature)

APPENDIX F: TECHNICAL DESCRIPTION OF DATA, RISK–ADJUSTMENT METHODS AND RESULTS

Since patients differ in the severity of their clinical condition, it is unfair to compare two hospitals based on their results in treating patients without taking these differences into account. CCMRP "levels the playing field" by accounting for the pre–operative condition of a patient at the time he or she is admitted to the hospital. This leveling is called "risk–adjustment." Hospitals that routinely handle tougher cases receive larger risk–adjustment factors, while hospitals that handle easier cases receive smaller ones. In adjusting for patients' risks, only those factors are included that describe the patient's condition as closely as possible to the time of hospital admission. The goal is to produce a statistical model that can be used to risk–adjust hospital outcomes by *removing* patient factors that exist prior to the hospitalization that can have an effect on survivorship. After accounting for these factors, what is left is presumed to be a combination of differences in the effectiveness of the care provided, plus some random error due to chance.

The modeling of CABG mortality can be approached in a number of ways, some of which are mentioned in our reference section. However, multivariate logistic regression models have become the standard method of analyzing binary data in health services research, and this is the method CCMRP selected. This section of the report describes in detail the methods used to create a risk–adjustment model and to calculate risk–adjustment factors for each hospital. Also discussed are some of the alternative models investigated and the detailed results. This technical appendix is organized into five main sections:

- ***Data***, which includes a discussion of how CCMRP selected the data elements (i.e., patient characteristics), data cleaning and manipulation procedures, and the process used to validate the quality of those data.
- ***Model Development***, which relates the patient characteristics to in–hospital mortality following isolated CABG surgery, and includes a discussion of how missing data elements were handled; and the choice of analytic technique.
- ***Model Fit and Validation***, which discusses the discrimination and calibration of the logistic regressive model.
- ***Alternative Models***, which includes a discussion of alternative analytic approaches.
- ***Hospital Risk–Adjusted Mortality Predictions***, in which we remove the effect of the patient characteristics on the outcome; what is left is an estimate of the effect of the hospital on the outcome.

Data

The risk analysis is based on 30,800 isolated CABG cases that CCMRP collected from 82 California hospitals that submitted data to CCMRP for 1997 and 1998. Although this is CCMRP's first public report, the number of cases and participating hospitals already makes CCMRP the largest public reporting program on coronary bypass surgery. Unlike CABG outcome reports produced by several other states in which participation is mandatory, CCMRP is voluntary and

hospitals choose to participate. For the 1997–1998 period, 79 hospitals out of 118 California hospitals that perform significant numbers of adult CABG surgeries chose to share their data for analysis and public reporting. Together these participating hospitals perform more than 70% of all CABG surgeries in California. Although the vast majority of hospitals joined CCMRP, we caution that the results and conclusions in this report are applicable only to those hospitals that submitted data and not to hospitals that refused to participate.

Because CCMRP continued to recruit throughout 1997 and 1998, the amount of data for each participating hospital may vary not only by the size of the hospital but also by when they chose to join. All hospitals in this analysis submitted data for 1998, but some also submitted data for all or part of 1997. In aggregate, about 38% of the total cases were from 1997 (11,808) and 62% were from 1998 (19,006). As an indication of continuing participation by hospitals, as of November 1, 2000, preliminary counts indicate that approximately 22,000 additional cases have been submitted for the year 1999.

CCMRP collected a small number of data elements for each adult patient who underwent an isolated CABG surgery (*isolated* means that no patient in this analysis received both a CABG and an additional major procedure such as a valve repair or replacement during the same operation) between January 1, 1997, and December 31, 1998. As discussed elsewhere in this document, our review of the clinical literature suggested that only a very small set of pre–operative data elements were necessary to risk–adjust isolated CABG surgery outcomes. The data elements (see Appendix A) focus on demographic characteristics and the pre–operative condition or risk factors of the patient, and they include all pre–operative data elements suggested by an expert panel for inclusion in any analysis of isolated CABG surgeries (see Jones et al., 1996). This expert panel identified seven "core" pre–operative variables that were unequivocally related to mortality, 13 "Level 1" variables that are likely to have a relationship, and 24 "Level 2" variables not clearly shown to relate directly to short–term CABG mortality, but which hold potential research or administrative interest. CCMRP collected all "core" and "Level 1" data elements, and almost all "Level 2" data elements.

A total of 802 patients (out of 30,814) died in–hospital following the procedure for an overall in–hospital death rate of 2.60%. To put this in context, in their January 2001 report on the outcomes for CABG surgery for 1998, the New York State Department of Health reported 405 deaths out of 18,814 isolated CABG cases for an overall in–hospital mortality rate of 2.15% (see www.health.state.ny.us). And, although not strictly comparable, the California Chapter of the STS reports an overall operative mortality rate for its California members of 3.03% for the three–year period from October 1, 1994, to September 30, 1997 (see www.casts.org). "Operative mortality" differs from "in–hospital mortality" used by CCMRP in that it measures mortality within 30 days of a CABG surgery (unless the cause of death is clearly not related to the operation). Because most (but not all) deaths after CABG occur within 30 days, operative mortality is generally higher than in–hospital mortality.

Data Collection. The data elements collected by CCMRP and used in the risk–adjustment model are a subset of the data elements collected by the STS for their National Database of Cardiac Surgery. Although the definitions used for each of these data elements were quite similar, to improve the quality and comparability of data submitted by hospitals, CCMRP required that hospitals send staff who would have responsibility for collecting these data to a training

session prior to being allowed to submit data. The training sessions were lead by a cardiologist. A training session included a short presentation of the goals of the project, a detailed discussion of variable definitions and coding practices, review of a series of training vignettes, and a quiz to test participant's knowledge and ability to code correctly given the definitions. After training, CCMRP collected data quarterly from participating hospitals. A copy of the training manual is available on the web from OSHPD (www.oshpd.state.ca.us/hpp), as well as videotape of a training session.

Data collection is continuing for current years. As a note for future interest, data elements and definitions for the year 1999 are exactly as those used for these data (1997–1998); however, a few changes have been made to CCMRP data elements for the year 2000 in accordance with updated definitions by the STS for their own national cardiac surgery database.

Data Cleaning and Transformation. Although each hospital was required to attend a training session prior to data submission, a great deal of variability occurred in the apparent distribution of data, necessitating substantial pre–analysis data cleaning. Upon receipt of the quarterly data, CCMRP staff conducted a series of short summary checks to ensure that no obvious errors had occurred (such as the omission of age or patient status). When they detected such errors, CCMRP staff contacted the hospital and requested either clarification or re–submission. Subsequent to this stage, staff performed minor data transformations (e.g., recoding of "Yes" to "Y" and "No" to "N," collapsing of race/ethnicity categories to "White" and "Non–white," and calculating ages from dates of birth and surgery).

The preliminary data cleaning found that the value of creatinine was missing or recorded as "0" in approximately one–third of all cases submitted for analysis. In 1997 and 1998 (and also for the year 1999), the STS did not collect creatinine values unless those values exceeded 2.0. As a result, this coding practice among hospitals participating in the STS system makes it impossible to distinguish in the CCMRP data set between creatinine values below 2.0 (i.e., missing by design) and those that are truly missing (whether the value is below or above 2.0). This was true of other data elements collected by CCMRP. The next section discusses the consequences, alternatives that CCMRP explored to address this problem, and the policy recommendation adopted to handle missing data. After considering the alternatives in the next section, CCMRP assumed that all missing values of creatinine were "normal," and assigned them the value 1.0 mg/dl.

The STS data system collects "Yes/No" values for several data elements, including some patient history elements that describe co–morbidities (e.g., presence or absence of diabetes) and conditions or procedures that apply to this admission (e.g., whether or not a PTCA was performed on this admission). These "Yes/No" data elements were also plagued by large numbers of missing values. As in the case of creatinine, CCMRP considered several alternative ways of handling this problem and ultimately decided to assume that whenever a value was not reported for these data elements that the value is "No." The data elements handled in this fashion are:

- Hypertension
- Dialysis
- Diabetes

- Peripheral Vascular Disease
- Cerebrovascular Disease
- Ventricular Arrhythmia
- Myocardial Infarction (ever)
- PTCA on Current Admission
- Chronic Obstructive Pulmonary Disease
- Congestive Heart Failure

Height and weight were too inconsistently coded to be used for analysis. Body Mass Index (BMI) or Body Surface Area (BSA) had been expected *a priori* to be important in our final logistic regression model, but because both height and weight are needed to calculate BMI and BSA, a missing or suspicious value in either element invalidates the entire calculation. Even when both data values were simultaneously available, detailed examination of the data submitted suggested the confounding of two types of errors: first, a failure to convert pounds and inches into metric kilograms and centimeters; and second, a possible switch where heights (in centimeters) may have been entered as weights (in kilograms) and vice versa.

Table F–1 shows the patient–level data elements (excluding height and weight) as they were distributed in the collected or raw data set. As can be seen from this table (and noted above), about one–third of all cases were submitted with missing creatinine values (9,937 of 30,814).

Table F–1: SUMMARY OF 1997–1998 RAW DATA SUBMITTED

30,814 total isolated CABG cases submitted by 82 hospitals

Status	Sex	Race	Hypertension	Dialysis	Diabetes
Alive:30012	Female: 8463	White:23531	No: 9866	No:26296	No:20453
Dead: 802	Male:22334	NonWhite: 7078	Yes:20848	Yes: 531	Yes:10216
	NA's: 17	NA's: 205	NA's: 100	NA's: 3987	NA's: 145

Periphvasc	Cerebrovasc	VentArrhythmia	COPD	PTCA
No:26482	No:25849	No:22741	No:26578	No:11718
Yes: 4195	Yes: 3239	Yes: 1594	Yes: 4058	Yes: 1153
NA's: 137	NA's: 1726	NA's: 6479	NA's: 178	NA's: 17943

CoMorbid	Prior Ops	MI	Angina	CHF
0:14199	0:28626	No:15613	None: 3136	No:25149
1:11110	1: 1988	Unknown: 959	Stable: 9821	Yes: 4975
2: 4071	2: 176	21+: 6606	Unstable:17719	NA's: 690
3: 1183	3+: 24	7+: 1267	NA's: 138	
4: 224		1+: 5012		
5: 26		0–1: 1108		
6: 1		NA's: 249		

NYHA	CCS	Acuity	LM Stenosis	Disease Type
I:14154	I: 2262	Elective:15190	<50%: 4910	Single: 1715
II: 4016	II: 5098	Urgent:13022	51–70%: 3109	Double: 5769
III: 5413	III:10590	Emergent: 1988	71–90%: 2101	Triple+:22802
IV: 3650	IV:11147	Salvage: 162	91+%: 802	LM Only: 313
NA's: 3581	NA's: 1717	NA's: 452	NA's:19892	NA's: 215

Mitral	Quarter	Age	Creatinine	Eject Fraction
None: 7235	1997–1: 3029	Min: 18.00	Min: 0.10	Min: 1.00
Trivial: 1060	1997–2: 3033	Mean: 66.07	Mean: 1.32	Mean: 53.87
Mild: 1136	1997–3: 2828	Median: 67.00	Median: 1.00	Median: 1.0055.00
Moderate: 473	1997–4: 2918	Max: 96.00	Max: 202.00	Max: 98.00
Severe: 104	1998–1: 4766	NA's: 14	NA's: 9937	NA's: 2866
NA's:20806	1998–2: 4759			
	1998–3: 4661			
	1998–4: 4820			

NA indicates that the data were missing.

Other data elements with even larger numbers of missing values include mitral insufficiency (20,806 missings), degree of stenosis of the left main coronary (19,892 missings), and a notation of whether or not a PTCA had been performed on the current admission (17,943 missings). Table F–3 summarizes the data after transformation and recoding, and prior to analysis.

Data Exclusions. Not all data submitted to CCMRP are included in this analysis. Notably, the data cleaning stage identified hospitals whose submissions showed unusually large numbers of missing values for potentially important explanatory factors. In consultation with these facilities, CCMRP staff were able to clarify and resolve many problems prior to analysis. Nonetheless, some unresolvable data problems remained and staff excluded from this analysis all or part of the data from two hospitals. In one of these two facilities (N.T. Enloe), the number of comorbidities appeared to be largely under–reported. In the other (St. Joseph of

Orange), there was a clear improvement in the completeness of reporting for important factors in 1998 compared to 1997. For both hospitals, the inclusion of large amounts of incomplete data would have made it impossible to distinguish between the quality of their care and the quality of their data. Worse, the inclusion of poor quality data from these two hospitals could have biased the model for all other hospitals in our data set. Accordingly, CCMRP omitted from further analysis all of Enloe's and St. Joseph of Orange's data for 1997. Additionally, because CCMRP is a voluntary program, a few hospitals withdrew prior to this analysis. While we analyzed data from 82 hospitals to compute the risk–adjustment model, three hospitals withdrew from the program after the analysis was completed but before this report was finished. No unusual patterns of incompleteness were observed among the data from these three hospitals so their inclusion in our analysis should not result in a biased model even though they declined to be identified in our report.

Audit of Hospital Data. After the preliminary data cleaning and analyses were completed, CCMRP developed and implemented an audit process meant to check the quality of the data submitted for 1998. CCMRP contracted with the Health Services Advisory Group (HSAG) to conduct the independent, external audit. HSAG is an Arizona–based peer–review organization with prior experience abstracting cardiovascular information from medical records. Six RN abstractors from HSAG attended a training class in which we used the same training materials that were used to train participating hospitals in data collection.

CCMRP selected for review all hospitals that were determined to be outliers (i.e., either higher than or lower than expected mortality rates based on a preliminary analysis of the 1997–1998 data), plus "near–outliers" on both ends of the spectrum. These near–outliers fell within the "no different than expected group." Two hospitals that had originally submitted data for analysis refused audit, a condition of participation; those hospitals were removed from our program and their data were dropped from further analysis.

HSAG abstractors attempted to review 40 charts on–site at each of 26 participating hospitals; as is the case in many hospitals, not every chart could be reviewed at the time when the auditors were present. A total of 1,006 total charts were reviewed from these 26 hospitals. Because this was CCMRP's first round of data checking, the main goal was to learn about the variability of coding and coding problems. Accordingly, these 40 charts per site were not chosen randomly but rather to highlight potential coding problems. Thus, the chart review can be thought of as an extended pilot test for future audits (recall that for the combined 1997–1998 data set, the overall in–hospital mortality rate was about 2.6%; had we chosen the cases for review randomly we would have expected about one death per hospital among our review set). To maximize our "learning set," staff focused on complex cases where either the calculated risk was high based on the data submitted, or the patient died. An unfortunate result of this non–random selection of cases is that statistical inference on our conclusions becomes much more difficult.

The abstraction process included a 5.0% over–read of charts to ensure accuracy in coding among abstractors. The abstractors gathered data on a blinded basis from the medical records at each hospital. The abstractors focused their review only on the data elements in the risk model that had a significant impact on the eventual health outcome of patients. Table F–2 lists the variables checked by the HSAG abstractors.

Table F–2: LIST OF AUDIT VARIABLES ABSTRACTED FROM MEDICAL RECORDS

Date of Birth	History of Dialysis	PTCA on Current Admission	Left Main Stenosis %
Gender	History of Diabetes	New York Heart Association Class	Date of Discharge
Admission Date	History of Peripheral Vascular Disease	Presence of Angina	Status of Discharge
Surgery Date	History of Cerebral Vascular Disease	Type of Angina	Location of Discharge (Home vs. SNF)
Surgery Time	History of COPD	Status (Acuity)	Date of Death
Creatinine Prior to Surgery	Ventricular Arrhythmia	Ejection Fraction	Date of Catheterization
Date of Creatinine	Date of Ventricular Arrhythmia	Date of Ejection Fraction	Verification that Case was Isolated CABG
History of Hypertension	Number of Prior Operations with Cardio Bypass	Source of Ejection Fraction	

After the abstraction process, HSAG provided a raw data file to CCMRP. The audited data were then compared against what the hospitals originally submitted to CCMRP, both in a series of NxN tables for each variable for each hospital (so that we could calculate concordance statistics) and also in a multivariate way by comparing estimated risks for each of the 1,006 reviewed cases based on submitted and audited values. Note that simple concordance tables, while informative in pinpointing coding problems that need to be fixed, do not reflect the relative importance of each variable to the overall risk–adjustment. The multivariate comparison could do so in a straightforward way. For example, as we shall see later when we discuss the results of our multivariate logistic regression model, a discrepancy in whether a hospital recorded a patient on dialysis matters far less for risk–adjustment than does a discrepancy in operative acuity.

The analysis of the audit results revealed a few issues with the submitted data that led CCMRP to request that several hospitals re–submit their data. In particular, several hospitals appeared to confound the coding of NYHA Class for measuring CHF and the coding of CCS Class for measuring angina.

The main question CCMRP sought to investigate by the audit was whether the rating of hospital quality depended on coding practice. For example, did hospitals that appeared to be better–performers exhibit systematic "coding creep," and did poorer–performing hospitals appear that way simply because they did a poor job of coding the data elements? CCMRP observed no overall systematic pattern of misstatement (e.g., neither "coding creep" nor data understatement), and a comparison of predicted risks based on submitted versus audited data showed that for the 26 audited hospitals, there was no relationship between the average risk level and a hospital's rating. There does appear to be a tendency for poorer–performing hospitals to be "sloppier" (i.e., to have less agreement between what was submitted and what

was audited) than better–performing hospitals. Nonetheless, had we relied on the audited data to compute the risk–adjusted rate for these hospitals, we would not have changed our conclusions about the poorer performing hospitals.

Model Development

Modeling Approach. There are many ways to approach the modeling of CABG mortality, some of which are mentioned in the reference section. CCMRP's modeling approach is state–of–the–art consistent with modern statistical practice,[10] and can be summarized with these key points:

- Use of expert opinion to select data elements (i.e., we did not select explanatory factors by "stepwise" techniques or by using "p–values"). The previous section discussed the data elements we collected and analyzed.
- Replacement of missing data in a way that discourages "coding creep" (i.e., we do not do listwise deletion of cases with missing data). This is discussed directly below in **Handling of Missing Values.**
- Use of multivariate logistic regression to model risk, but we did not automatically presume factors will be linear in log–odds.
- Assessment of fit through cross–validation.

Handling of Missing Values. Of the 30,814 cases included in the risk analysis, age could not be determined for 14 cases. These cases were omitted from further analysis, reducing the working number of cases to 30,800. Consistent with standard practice, the entire data set was divided randomly into two parts, a "training set" used to develop the model and a "test set" to assess fit. Also consistent with standard practice, after a final model was chosen and tested, the coefficients were re–estimated from the entire data set. These are the coefficients shown in this document.

To determine the influence of missing data values and either to replace or impute values if possible, CCMRP performed several exploratory analyses of the test data set examining four different alternatives in handling the missing values.

In the first alternative, an initial model was estimated on the test data set via stepwise logistic regression using listwise deletion of rows with missing values (that is, if any value for any data element was missing from a case, the entire case was omitted); fortunately few of the data elements with large numbers of missing values survived the culling process to the final model.

[10] See, for example, Harrell (1998).

For the second alternative, CCMRP created a data set with missing values replaced with medians (or modal values for factor variables), and re–analyzed using the same stepwise logistic regression approach. For example, a missing value for "Race" was replaced with "White" (for those cases where race was recorded, 23,531 were listed as "White" and 7078 were listed as "Non–white"; accordingly, the 205 cases with missing race were assigned to "White"). Of note, "modal replacement" means that a missing value for NYHA CHF Class was replaced with Class I, but a missing value for CCS Angina Class was replaced with Class IV. Data elements for which a large fraction of assignments were made include: PTCA on current admission (labeled "PTCA"), degree of stenosis of the Left Main coronary artery ("LM"), and degree of mitral insufficiency ("Mitral"). Although very few missing assignments were made for the "Disease Type," note that "Triple vessel disease" is by far the most commonly reported type of coronary artery disease. After these missing data assignments were made, staff re–analyzed the data and compared them with the elements identified in the preceding step. The same variables survived to the final model, with coefficients of the same sign. Although this does not resolve the issue of missing variable bias, it is reassuring that missing data do not seriously affect the model (at least in a multivariate way). As we shall see later, of the explanatory factors included in the final logistic regression model, the two major elements with large numbers of missing values are creatinine and ejection fraction. Many (but not all) hospitals collected creatinine values only if they exceeded 2.0 mg/dl, so values under 2.0 at these hospitals were unobservable, or "censored." In addition, out of the entire data set of almost 31,000 cases, 12 cases were reported with creatinine values exceeding 20 mg/dl and an additional 45 cases with creatinine above 10 mg/dl. These 57 cases appear to be either mis–entered or true outliers (For example, several of the 12 cases with creatinine values like "202" or "106" probably result from keystroking a "0" rather than a ".", and that the actual values likely were 2.2 and 1.6, but in the latter case the value as easily could have been 10.6). For these 57 cases, staff truncated their values at 10 mg/dl (e.g., staff did not attempt to re–code "202" to "2.2"). Truncating these 57 cases had an enormous effect on the coefficient for creatinine, which increased by a factor of three.

As a third alternative, CCMRP replaced creatinine values with a normal value (1.0 mg/dl) for these censored or missing cases. Similarly, missing values for ejection fraction were replaced with a preliminary guess at a "normal" value (60%). In addition, eight cases were observed with ejection fraction below 15%, and these were also replaced with a value of 60%. Stepwise logistic regression models were then re–estimated with similar data elements surviving to a final model, and surprisingly little change in the coefficients except for creatinine.

A fourth alternative, and the one ultimately recommended by our advisory committee, is to replace missing values with the lowest risk category for each data element (based on the test data set). Compared to the second alternative, this means that missing CCS Class is replaced with category III, and missing Angina is replaced with "Stable." This is the alternative that was chosen. The CCMRP Technical Advisory Panel recommended adopting this approach to replacing missing data because it would be consistent with the missing data practices of other large bypass graft reporting systems and would give hospitals a strong incentive to submit complete data to ensure full credit for more severely ill patients.

Table F–3: SUMMARY OF 1997–1998 DATA ANALYZED*

30,800 total isolated CABG cases submitted by 82 hospitals

Status	Sex	Race	Hypertension	Dialysis	Diabetes
Alive:30012	Female: 8463	White:23736	No: 9866	No:30283	No:20598
Dead: 802	Male:22351	NonWhite: 7078	Yes:20948	Yes: 531	Yes:10216
Periphvasc	**Cerebrovasc**	**VentArrhythmia**	**COPD**	**PTCA**	
No:26619	No:27575	No:29220	No:26756	No:29661	
Yes: 4195	Yes: 3239	Yes: 1594	Yes: 4058	Yes: 1153	
CoMorbid	**Operation**	**MI**	**Angina**	**CHF**	
0:14199	1st:28626	No:15862	None: 3136	No:25839	
1:11110	2nd: 1988	Unknown: 959	Stable: 9959	Yes: 4975	
2: 4071	3rd: 176	21+: 6606	Unstable: 17719		
3: 1183	4+: 24	7+: 1267			
4: 224		1+: 5012			
5: 26		0–1: 1108			
NYHA	**CCS**	**Acuity**	**LM Stenosis**	**Disease Type**	
I: 17735	I: 2262	Elective: 15642	<50%: 24802	Single: 1715	
II: 4016	II: 5098	Urgent: 13022	51–70%: 3109	Double: 5769	
III: 5413	III: 11307	Emergent: 1988	71–90%: 2101	Triple+:23017	
IV: 3650	IV: 11147	Salvage: 162	91+%: 802	LM Only: 313	
Mitral	**Quarter**	**Age**	**Creatinine**	**Eject Fraction**	
None:28041	1997–1: 3029	Min: 18.00	Min: 0.10	Min: 15.00	
Trivial: 1060	1997–2: 3033	Mean: 66.07	Mean: 1.18	Mean: 53.87	
Mild: 1136	1997–3: 2828	Median: 67.00	Median: 1.00	Median: 55.00	
Moderate: 473	1997–4: 2918	Max: 96.00	Max: 10.00	Max: 98.00	
Severe: 104	1998–1: 4766				
	1998–2: 4759				
	1998–3: 4661				
	1998–4: 4820				

*Note: The 30,800 cases are those that remain after dropping 14 cases with missing age and imputation of missing values.

Logistic Regression Models: Although there are many valid approaches to modeling binary outcomes (like survivorship or death), the most common and widely accepted method in use today is multivariate logistic regression. CCMRP relies on this approach, supplementing it with generalized additive models.[11] Additionally, to help summarize the data and identify interactions among the factors, CCMRP uses tree models, a recursive partitioning technique.[12]

Table F–4 summarizes a logistic regression model based on data with the missing values for creatinine and ejection fraction replaced as described above, and includes all data elements. The table shows an overall multivariate logistic summary of all variables being considered, and is often used as a starting point for variable selection using stepwise or other similar techniques.

[11] Logistic regression is a type of generalized linear model, or GLM. Generalized additive models are an extension of GLM's that allow examining nonlinear transformations of the explanatory factors.

[12] For a complete discussion of these statistical techniques, see Hastie and Tibshirani (1990) for an introduction to generalized additive models; Zhang and Singer (1999) for recursive partitioning trees; and Collet (1991) or Hosmer and Lemeshow (1989) for multivariate logistic regression models.

Table F-4: CCMRP 1997–1998 Logistic Regression Model

Explanatory Factor	Coefficient	Std. Error	t–value	Odds Ratio	Missing Variable Assignment
(Intercept)	–7.206	0.411	–17.512		
Age (in years)	0.044	0.004	**10.812**	1.05	Case Excluded
Sex					
Female	Reference				
Male	–0.401	0.080	**–5.005**	0.67	Male
Race					
White	Reference				White
Non–white	0.203	0.088	**2.294**	1.23	
Creatinine (mg/dl)	0.214	0.039	**5.433**	1.24	1.0; Truncated at 10
Hypertension	0.075	0.087	0.866	1.08	No
Dialysis	–0.029	0.275	–0.105	0.97	No
Diabetes	0.142	0.080	1.776	1.15	No
Peripheral Vascular Disease	0.435	0.091	**4.800**	1.54	No
Cerebrovascular Disease	0.244	0.101	**2.410**	1.28	No
Ventricular Arrhythmia	0.337	0.123	**2.737**	1.40	No
COPD	0.275	0.094	**2.914**	1.32	No
Operative Incidence					
First	Reference				First Operation
Second	0.674	0.118	**5.733**	1.96	
Third	1.354	0.276	**4.901**	3.87	
Fourth or Higher	1.823	0.660	**2.763**	6.19	
Myocardial Infarction					
None	Reference				None
Yes, but When Unknown	0.156	0.196	0.797	1.17	
21+ Days ago	0.028	0.105	0.263	1.03	
7–20 Days ago	–0.227	0.198	–1.145	0.80	
1–6 Days ago	0.237	0.107	**2.211**	1.27	
Within 1 day	0.876	0.150	**5.831**	2.40	
PTCA on This Admission	0.220	0.156	1.411	1.25	No
Angina					
None	Reference				
Stable	–0.369	0.137	**–2.691**	0.69	Angina Stable
Unstable	–0.256	0.129	**–1.977**	0.77	
NYHA CHF Class					
I	Reference				NYHA Class I
II	0.506	0.122	**4.141**	1.66	
III	0.549	0.109	**5.037**	1.73	
IV	0.769	0.102	**7.530**	2.16	
CCS Angina Class					
I	Reference				
II	0.178	0.192	0.927	1.19	
III	0.070	0.173	0.404	1.07	CCS Class III
IV	0.211	0.175	1.203	1.23	

Table F-4: CCMRP 1997–1998 Logistic Regression Model (cont.)

Explanatory Factor	Coefficient	Std. Error	t–value	Odds Ratio	Missing Variable Assignment
Acuity					
Elective	Reference				Elective
Urgent	0.221	0.090	**2.449**	1.25	
Emergent	0.743	0.136	**5.482**	2.10	
Salvage	2.806	0.218	**12.860**	16.55	
Ejection Fraction (%)	–0.012	0.003	**–4.393**	0.99	55; Truncated at 15.0
Left Main Stenosis					
0–50%	Reference				0–50%
51–70%	–0.015	0.126	–0.117	0.99	
71–90%	0.233	0.130	1.786	1.26	
91+%	0.525	0.153	**3.426**	1.69	
Type of Coronary Disease					
Single Vessel	Reference				Single Vessel Disease
Double vessel	–0.176	0.181	–0.974	0.84	
Triple or More	0.069	0.160	0.433	1.07	
LM Only disease	0.447	0.359	1.244	1.56	
Mitral Regurgitation					
None	Reference				None
Trivial	0.506	0.158	**3.203**	1.66	
Mild	0.247	0.151	1.638	1.28	
Moderate	0.612	0.192	**3.187**	1.84	
Severe	0.898	0.345	**2.598**	2.45	

Age, ejection fraction, and creatinine were entered as continuous variables; the other variables were entered as ordered factors. For the variables entered as ordered factors, the coefficients should be compared to the reference category (for example, we show coefficients for NYHA Classes II, III, and IV; those coefficients are compared to the reference category of NYHA Class I). Bolded t–values indicate the coefficient for that variable is statistically significant at the 0.05 level.

The model shown above in Table F–4 is the result of a logistic regression where the outcome variable is in–hospital mortality. Age, ejection fraction, and creatinine have been entered as continuous variables; the other variables have been entered as ordered factors. Logistic regression coefficients reveal the contribution of each data variable to the logarithm of the odds (log–odds) of in–hospital mortality; thus, a coefficient on age of 0.044 means that an increase in one year of age is associated with an increase of 0.044 in the log–odds of in–hospital mortality. For the variables entered as ordered factors, the coefficients should be compared to the omitted category (for example, we show coefficients for NYHA Classes II, III, and IV; those coefficients are compared to the omitted category of NYHA Class I).

Logistic regression models relate the probability of death (or, more accurately, the log–odds of death) to a number of explanatory factors, such as the age of the patient, the amount of creatinine in the blood, or whether this is the first cardiac operation this patient has undergone. For each explanatory factor, CCMRP includes columns that list the coefficient (or weight) of the explanatory factor, its standard error, the t–value, and an odds ratio. Of note, although several of the variables do not appear to be "statistically significant" (as determined

by the t–value), almost all of the coefficients appear with the sign that clinical judgment predicted.

Table F–4 can be thought of as a summary of the data CCMRP staff analyzed, and it may be helpful to explain how to interpret the table. It is important to understand that the table shows the results from a multivariate logistic regression, and therefore describes the relationship between in–hospital mortality and each explanatory factor after taking into account each of the other factors.

The **coefficient** of the explanatory factor measures how much the probability of in–hospital death (the log–odds) is affected if a patient has that factor (for categorical factors like whether the patient has diabetes). If the value is positive, it means that having that factor or characteristic is associated with an increased risk of death compared to not having it (after taking into account the effect of all of the other factors). If it is negative, having that factor or characteristic is associated with a lower risk of death compared to not having it. (Some articles refer to a characteristic with a negative coefficient as having a "protective" effect. We avoid that confusing and misleading usage). The larger the value is (whether positive or negative), the more effect this factor has on the risk of dying. For example, notice that the value of peripheral vascular disease is 0.435. This value is positive, so it means that having peripheral vascular disease is associated with an increased risk of dying in–hospital for CABG patients compared to not having the disease. On the other hand, notice that male has a value of –0.401. Since this value is negative, it means that in these data males have a lower probability of dying in–hospital than females even after taking into account all other factors. For continuous factors, like age or the creatinine level, the coefficient measures how much a one unit increase in that factor (either years of age or mg/dl of creatinine) affects the log–odds of death.

Another way of assessing the strength of each factor is to examine the column labeled **odds ratio**. The odds ratio is the antilogarithm of the column labeled "coefficient," but is often more familiar to those in the health sciences. The larger the odds ratio, the larger the impact that factor has on the risk of dying. An odds ratio close to 1.0 means that the effect of the factor is close to neutral. For example, notice that the odds ratio for peripheral vascular disease is 1.54. This means that in these data the odds of dying in–hospital if the patient has peripheral vascular disease is about 1.54 times higher than if the patient did not have it. Being male has an odds ratio of 0.67, and this means that the odds that a man will die in–hospital after CABG surgery is about 0.67 times as high (i.e., about two–thirds as much) as for a woman.

The column labeled **t–value** is a measure of the statistical significance of the coefficient for that factor. When the t–value is large (whether positive or negative), it indicates a fairly large amount of confidence that the effect of the factor is real. If it is small, we have much less confidence that the contribution of the factor is not spurious. A common (and commonly misunderstood) rule–of–thumb for interpreting this column is that an absolute t–value larger than 2.0 indicates that the effect of the factor is real. Note that the t–value for the male explanatory factor is –5.005. This is larger (in absolute value) than 2.0, and thus suggests even after accounting for all of the other listed variables, the sex of the patient is a statistically significant factor in explaining in–hospital mortality for CABG patients.

Not all explanatory factors in the model have t–values larger than 2.0. For example, the t–values for CCS angina Class and the type of coronary artery disease (single vessel, double, triple or more, or left main only) are all quite small. At least in these data, neither type of coronary disease nor CCS Class for measuring angina is a reliable predictor of in–hospital mortality. Note that a small t–value does *not* mean that factor has no effect on in–hospital mortality—it means that its effect, if any, is not reliably estimated.[13] In addition, the variable ought to be marked as significant or insignificant, not the coefficient. This distinction becomes clearer when one recognizes that we estimate separate coefficients for different levels of several variables that take on more than simple Yes/No values, such as for myocardial infarction and the degree of congestive heart failure ("NYHA CHF Class"). Although the individual coefficient for "MI: Yes, but when unknown" is marked with a t–value that one could interpret as saying that the coefficient is not distinguishable from zero in a statistical sense, the entire "MI" variable is decidedly significant. The only variables that appear entirely unhelpful are CCS angina Class, the type of coronary artery disease ("left main disease only"), dialysis, and hypertension. On the borderline are diabetes and especially "PTCA on this admission," which has a large effect but whose statistical reliability may be undermined by small sample size since its occurrence is rare.

Inclusion of Variables. CCMRP's approach to the inclusion of important variables is different enough from usual practice to warrant a note. It is common in other studies to include large numbers of candidate variables at an early analytical stage, and to go through a winnowing process to reduce the number of predictor variables to a manageable few. Methods such as stepwise regression have become popular because of their ability to do so in an automated way. CCMRP did not seek a model with a primary focus on parsimony. Clinical experts have already identified the candidate variables (Jones et al., 1996) that should be included. Rather, our goal is to find a model that predicts well, and we concern ourselves with whether the inclusion of a statistically "non-significant" coefficient trades off too much bias in favor of smaller variance. Winnowing down the variable list based on t-values (or similar measures) is where models often get into trouble with over–fitting. For example, the t-value on "71%-90% stenosis of the left main coronary artery" is "only" 1.79, but the effect is large, and it is consistent not only with clinical theory but also with the values below and above it. Clearly, in the context of the whole variable, it is important, but strict adherents of the 5.0% statistical significance rule would eliminate this variable from explanatory or predictive models.

Because this technical appendix focuses more on our analytical methods rather than the results, only an abbreviated discussion of our findings appears here. Nonetheless, a few of the more interesting observations are these:

- Age, acuity (i.e., how urgent the operation was), ejection fraction, and operative incidence are very important risk–model variables.
- Even after controlling for all other variables, sex appears to have a statistically significant effect, with males having about one–third lower mortality. There is some suggestion in the literature that sex may be a proxy for body size; unfortunately,

[13] This is particularly true for binomial GLM's when the fitted probabilities are close to zero (as occurs here) or one.

although we attempted to collect height and weight in order to construct an index of body mass, the data we received were plagued with either missing values or the apparent confusion of metric (kilogram and centimeter) and English (pound and inch) units. We intend to focus on this issue in our next series of training sessions and hope to include this variable in future analyses.

- After accounting for creatinine levels, dialysis appears to have no additional explanatory power. That is, even if a dialysis patient has higher creatinine levels than the average patient, once one knows that level the fact that the patient is on dialysis appears to add no additional information. This observation may seem odd to readers who are more familiar with binary (rather than multivariate) analyses particularly since we estimate the coefficient on dialysis to be very slightly negative. It is often the case that a continuous variable like Creatinine will "carry" more information than a discrete binary variable like Dialysis: yes or no?
- Patients with no angina have higher risk of in–hospital death than patients reported as having either "stable" or "unstable angina." Patients with no angina are unusual in that the majority of patients undergoing isolated CABG surgery have either "stable" or "unstable angina." Table F–1 (**Technical Appendix**) shows that only about 10% of the patients are classified as having "angina, none."
- The NYHA Class, used to measure the degree of congestive heart failure, appears to make a "natural" split between NYHA Class I and NYHA Classes II, III, and IV.
- CCS Class, used to measure the degree of angina, appears not to have much explanatory power. We conjecture that because the majority of CABG patients suffer from Class III or Class IV anginal pain, there is insufficient variability in these data to distinguish mortality differentials, i.e., since patients are likely to be selected for surgery based on the degree of angina, once we have restricted our data to patients who have had CABG surgery the degree of angina provides no additional explanatory power.
- The coefficients on the MI variable seem to indicate that an MI more than one week before the CABG procedure has an effect on risk indistinguishable from no MI at all, even after controlling for the acuity of the operation.
- Moderate amounts of stenosis of the Left Main coronary artery (up to about 70% stenosis) do not appear to have much of an elevating effect on the risk of in–hospital mortality. Stenosis beyond this level appears to have a much larger effect. Note that the usual analysis might conclude that a 75% stenosis is statistically indistinguishable from no stenosis because the t-statistic is less than 2.0 (it is 1.79). As an interesting sidenote, for the year 2000, the Society of Thoracic Surgeons Adult Cardiac Database will be collecting data only on whether stenosis of the left main coronary artery exceeds 50% and will no longer collect data on how much beyond 50% a stenosis is.
- Of the comorbidities we collect, peripheral vascular disease appears to have the largest effect.

- The number of vessels affected with coronary disease appears to have an effect in the hypothesized direction, but the effect is not statistically distinguishable from no effect.
- While "moderate" and "severe" mitral regurgitation appear to have effects as would be expected from a clinical standpoint, "mild" regurgitation is anomalous in appearing to have a lesser effect than "trivial." This may result from coding confusion between these two categories and CCMRP intends to focus on this distinction in future data collection training sessions.
- It may be possible to collapse several of the factor levels, such as for MI or mitral regurgitation, into fewer categories.

Model Fit and Validation

How can we be sure that the model estimated above is both a good summary of the data and also can be a valid basis for risk–adjustment? Earlier sections of this appendix addressed issues of data validity (see **Audit of Hospital Data**, and **Handling of Missing Values**) and content validity (**Data**). Structural validity is discussed in part in the next section, **Alternate Models**. In this section, we focus on discrimination and calibration of our logistic regression model.

Discrimination. Models that distinguish well between patients who die and those who survive are said to have good discrimination. A commonly used measure of discrimination is the c–index (also known as the c–statistic or the area under the ROC curve). The c–index ranges between 0.0 and 1.0, with higher values indicating better discrimination. For the model in Table F–4, the c–index is 0.803. In comparison, c–indexes reported in other published studies of CABG mortality that use logistic regression (including those from New York and the STS) range from about 0.74 to about 0.82. We conclude that the CCMRP model discriminates as well as these studies. For risk–adjustment purposes, it is generally thought that discrimination is a less important measure of model fit than calibration.[14]

Calibration. Calibration refers to the ability of a model to match predicted and observed death rates across the entire spread of the data. A model where the numbers of observed deaths align well with the numbers of deaths predicted by the model demonstrates good calibration. Because good calibration is essential for reliable risk–adjustment, we focus most of our attention on model fit on calibration.

A common measure of calibration is Hosmer and Lemeshow's chi-square statistic, which compares observed and predicted outcomes over deciles of risk. Although Table F–5 below shows the data necessary to calculate the Hosmer–Lemeshow $\chi 2$ (the test statistic is 13.15 with 8 df, p=.10, indicating that our model hews to the data moderately well), in recent years Hosmer and Lemeshow have begun to reassess this test statistic because it is sensitive to cutpoints and the number of groups.[15] Accordingly, of more general interest is direct examination both of the table and of the entire calibration distribution.

[14] The opposite is generally thought to apply in clinical or diagnostic settings, where discrimination is considered far more important than whether an overall model calibrates to the data well.

[15] See, for example, Hosmer, Hosmer, le Cessie, and Lemeshow (1997).

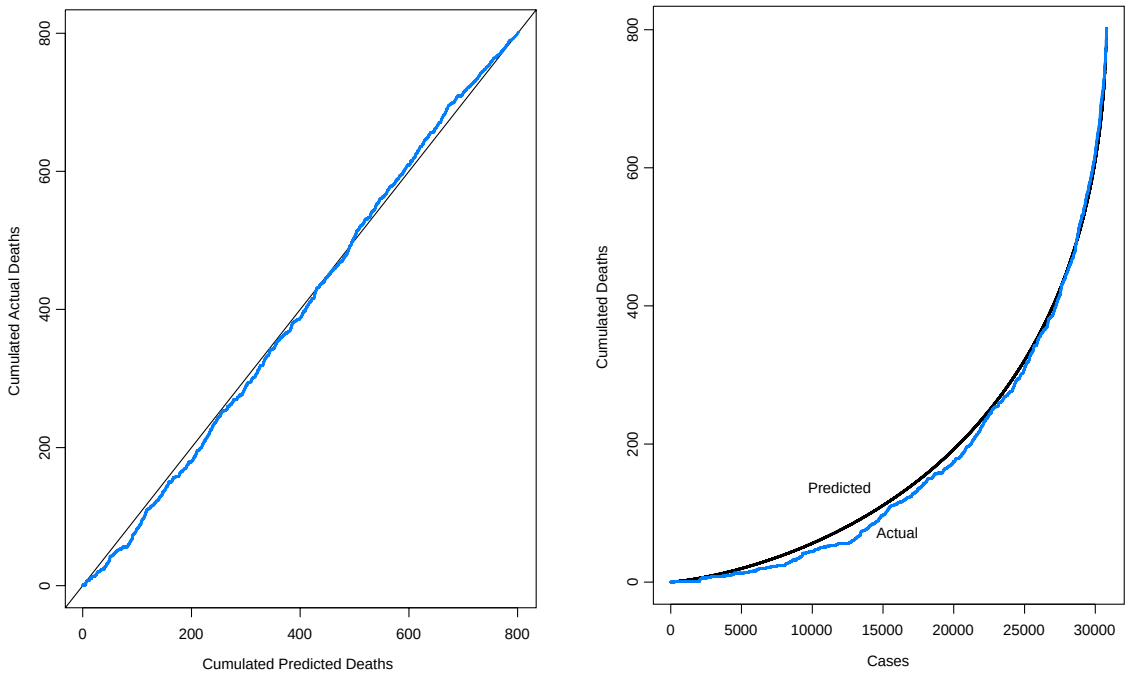
Table F–5 provides a summary comparison of our model to the data. There are 30,800 patients in our data set, so the first row of the table reports that of the decile of patients at lowest risk of in–hospital death based on our model (i.e., the 3,080 patients whose predicted risk of dying ranged from 0 to 0.5%), only eight died. Our model predicted that 10.1 of the patients in this decile group would have died. In other words, for this group of more than 3,000 patients (more than the average California cardiac surgery program would see in a decade), we observed 8 deaths and predicted 10.1. This means that our model predicted very slightly more deaths (2 deaths more) for this lowest risk group than actually occurred. On the other hand, the last row of Table F–5 says that of the "riskiest" decile of patients, 369 died, while our model predicted 366.8 deaths from this group (2.2 deaths fewer). Although the calibration appears good overall, our model appears to slightly "over predict" mortality for the least risky cases compared to the most risky cases (i.e., the model appears slightly to underfit the data), but not at a statistically significant level.

Table F–5: MODEL CALIBRATION

Decile Group	Predicted Risk of Dying	Actual Deaths	Predicted Deaths	Difference in 3,080 Patients
1	0 – 0.44%	8	10.1	–2.1
2	0.44% – 0.64%	10	16.7	–6.7
3	0.64% – 0.84%	19	22.8	–3.8
4	0.84% – 1.08%	19	29.5	–10.5
5	1.08% – 1.36%	50	37.4	+12.6
6	1.36% – 1.74%	46	47.4	–1.4
7	1.74% – 2.31%	58	61.9	–3.9
8	2.31% – 3.20%	85	83.6	+1.4
9	3.20% – 5.33%	138	126.0	+12.0
10	5.33% – 90.12%	369	366.8	+2.2

The following two graphs help explain the calibration of the CCMRP risk model. The first graph (below left) shows a plot of the cumulative number of predicted deaths based on our model against the number of actual deaths. The closer our predictions are to the actual experience, the closer the curve will be to the superimposed 45-degree line. Overall, the predictions appear to track the actual observed deaths well, but with the slight "underfit twist" noted above.

The right-hand graph plots the Actual and Predicted number of cumulative deaths against all 30,800 cases. The "smooth" curve summarizes the CCMRP predictions, while the slightly jagged curve shows the actual deaths. Because the model calibrates to the data well, the two curves lie close to each other. In addition, both curves are relatively flat toward the left and increase rapidly toward the right, akin to so–called "exponential" curves, demonstrating that the majority of CABG surgeries are low in risk while most in-hospital deaths appear to be concentrated in a relative handful of higher–risk patients. Half of 30,800 (the number of total



cases in our analysis) is 15,400, and one can see from this graph that approximately 100 deaths occurred to the 15,000 patients of lowest risk (exactly 106 out of 15,400, for a median risk of in–hospital death of 1.4%), while the remaining 700 deaths were concentrated in the upper half of cases. Although the overall average in–hospital mortality rate following isolated CABG surgery is already a low 2.6%, it is perhaps even more impressive that the average risk of death for the less–risky half is 0.7%, emphasizing that modern CABG surgery is remarkably survivable. Note that, although not drawn in, a straight line connecting the lower leftmost point with the upper rightmost point identifies a "constant risk" line of 2.6%, and would emphasize how much improved our model is compared to unadjusted risk models.

Three features concerning calibration of the model emerge in the graphs and in Table F–5:

- The majority of cases exhibit low risk. Nonetheless, the range of predicted risks (from almost zero to 90%) seems adequately wide, suggesting that our model does well at covering the potential range of risks. This addresses the common belief that risk models cannot be used for high risk patients.
- The model fits very well in the higher risk categories. For patients whose predicted risk exceeds 5.33%, the number of predicted deaths almost exactly matches the number of deaths actually observed, and the total number of predicted deaths for predicted risks above 1.36% is quite close to the observed. This suggests that risk–adjustment for higher risk patients is quite good. **The CCMRP concludes that this model does not provide an incentive for hospitals to exclude high–risk patients from appropriate surgeries in order to improve their risk–adjusted rates.**

- There may be slight evidence that the model over–adjusts at the lowest risks, but this evidence is statistically non–significant and the over–adjustment is relatively small.

Alternative Models

An examination of the coefficients in Table F-4 reinforces that (almost) all of the explanatory factors have effects in the directions expected by clinical experience, though some do not have t–values large enough for these effects to be reliably estimated. In particular, CCS Class, type of coronary artery disease, and some of the co–morbid conditions (hypertension and dialysis) fall into this category. Although the common analytical approach is to drop "non–significant" explanatory factors, modern statistical practice frowns on this, in part because ad hoc selection of factors invalidates tests of fit, particularly the discrimination and calibration tests described in the previous section.

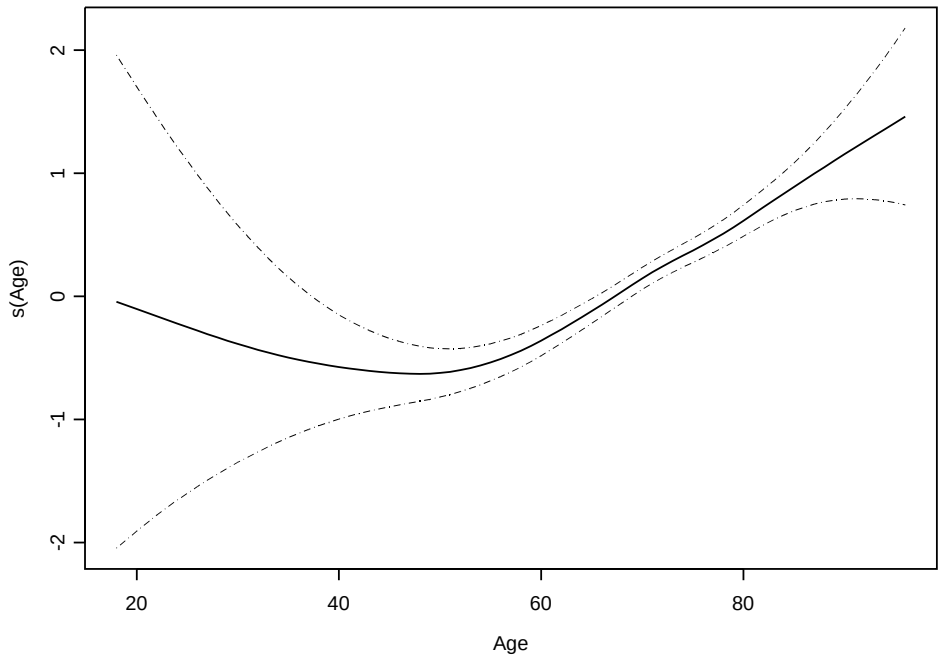
Nonetheless, CCMRP examined a series of alternative models which may be helpful in developing a future model. In that spirit, staff formed a series of two–way interaction terms and used forward stepwise regression to cull through the terms. In addition to the variables noted above (CCS Class, coronary disease type, and some of the comorbidities), no single two–way term survived the stepwise selection.

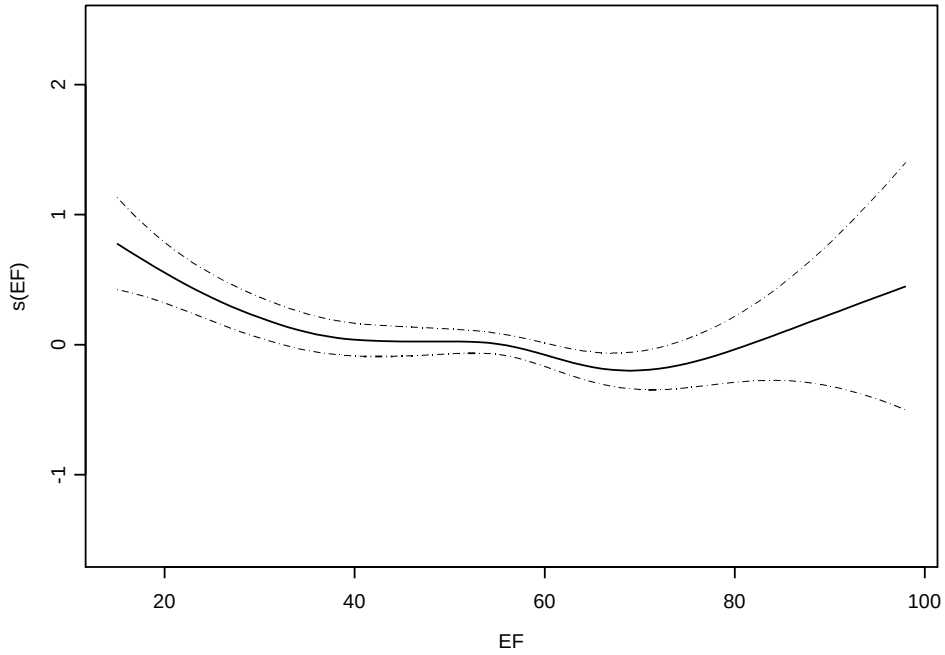
Staff then constructed a comorbidity index by summing the number of "Yes" responses for each patient for the six comorbidity variables (dialysis, diabetes, peripheral vascular disease, cerebrovascular disease, ventricular arrhythmia, and chronic obstructive pulmonary disease), implicitly giving each an equal weight (similar indices have been examined by others). The index was then entered into a new analytical formulation, both in linear and polynomial formulations (since the index is a linear combination of the individual comorbidities, it was not entered as a linear term simultaneously with the comorbidities themselves). As will be seen below, this constructed index turns out to be a useful predictor, especially in the classification tree model.

To investigate whether the logistic regression model would benefit from transformations of the continuous data variables, staff analyzed a series of **Generalized Additive Models** (GAM's), which allow for nonlinear (or "curved") relationships in the data. Although the GAM does marginally better than the regular logistic regression, its additional complexity was not judged worthy of further development for this analysis.

Two intriguing but inconclusive indications may be worth future investigation. Below, are partial residual plots for the GAM. They suggest:

- The effect of age on the log–odds of in–hospital mortality may be nonlinear, with a potential flattening below age 50 or 55; and
- The effect of ejection fraction on the log–odds of in–hospital mortality may also be nonlinear, with a potential flattening above (approximately) 60% or 65%.





If these results prove consistent, the functional conclusion is that CABG patients younger than about 50 do not get any additional protective effect from their age, nor do patients with ejection fractions much above "normal." The implication for risk–adjustment models is that both age and ejection fraction may be better modeled by using piecewise linear terms, with knots at about age 50 and ejection fraction about 65% (i.e., without a piecewise linear correction, logistic regression models like the one estimated in Table F–4 may slightly underestimate the effect on mortality of low ejection fractions and older age). An estimation

of such piecewise linear models showed these changes in the coefficient values with a (marginally) superior fit to the data. Nonetheless, it is premature to use such terms in our risk–adjustment model until further analysis is done.

In parallel to the logistic regression, but done entirely separately, another analytical approach was explored using a **Multivariate Classification Tree**, a recursive partitioning technique. A classification tree based on all data elements and all 30,800 cases was constructed. In tree–based analyses, binary splits are chosen by finding the best way to partition the data so that each new partition or "split" is as homogeneous[16] as possible and as different from the other split as possible. This splitting is continued until each final node is as homogeneous as desired–in theory, there can be 30,800 final nodes for the 30,800 cases, which is an unwieldy size. In practice, one chooses a tree of a workable size. Figure F–1 displays such a "working" tree, which prunes the less important splits at the bottom but keeps the more important splits at the top. The splits help identify the data elements that are important in achieving a good fit and almost the same variables show up in this tree analysis as in the stepwise logistic regression. The fact that two such different modeling approaches seem to identify the same important data elements is reassuring.

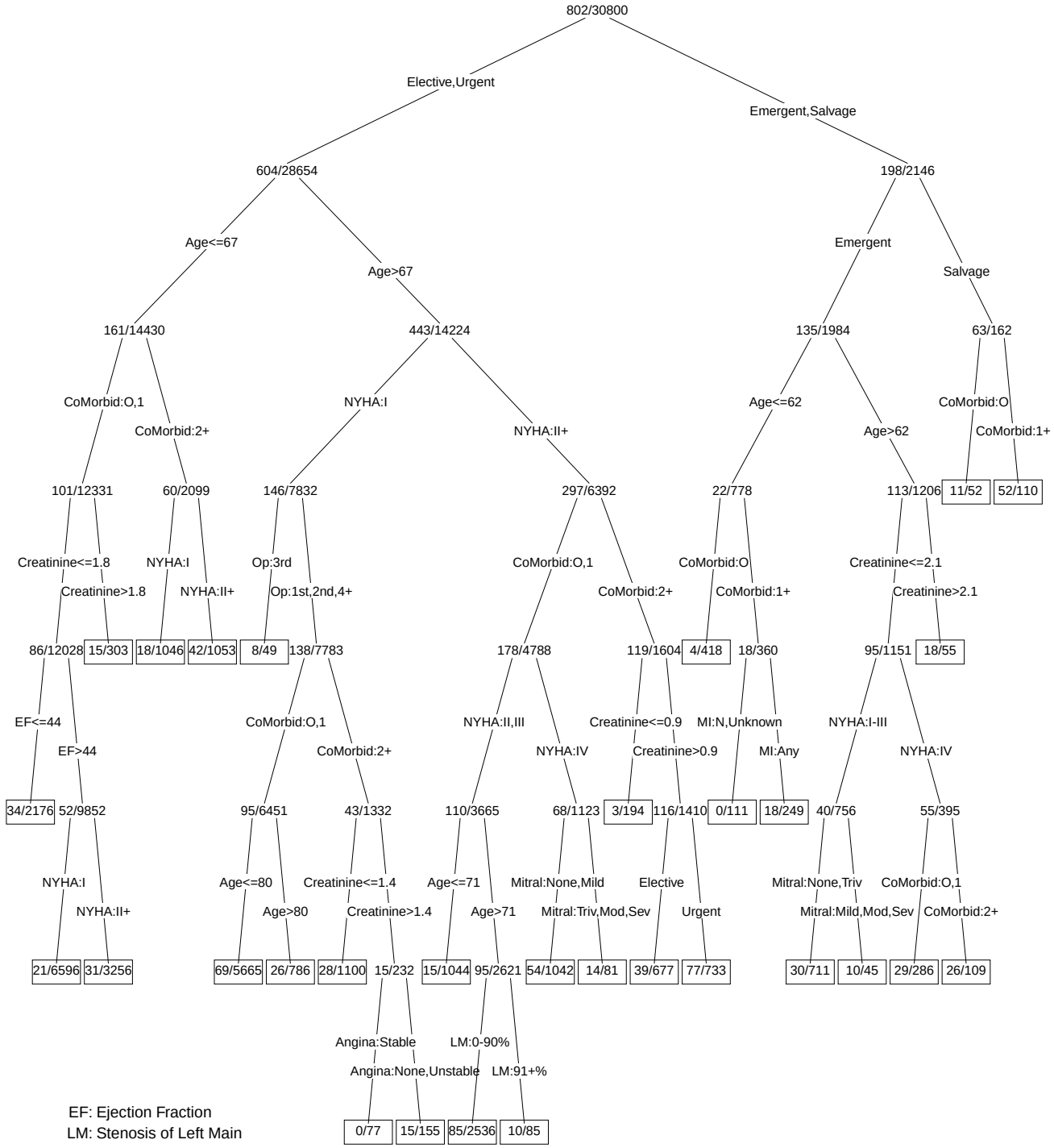
Figure F–1, the "working" tree, shows at its top an initial node labeled "802/30800." This indicates that of the 30,800 patients in our isolated CABG data set, 802 died in–hospital for an overall mortality rate of 2.60%. The tree also shows an initial split on acuity, with elective and urgent patients being separated from emergent and salvage patients. This means that of this entire data set, the single split that separates the data into two groups that are most different between groups and most alike within groups is the split in the data on acuity between "urgent" and "emergent." In essence, the single question that best splits patients into lower and higher risk groups is, "Is this patient's acuity either emergent or salvage?" The left branch of the tree (the elective/urgent branch) comprises 28,654 cases of the total 30,800 and that grouping is labeled as "604/28654" indicating 604 in–hospital deaths out of 28,654 cases (about 2.11%). The right branch of the tree is labeled "198/2146" and indicates that 198 deaths occurred to the 2146 cases whose acuity was either emergent or salvage (about 9.2%).

On the right of the tree, we see that the next split is once again on acuity, and it separates emergent cases (135/1984, or a mortality rate of 6.8%) from salvage cases (63/162, or a mortality rate of 38.9%). Further, the salvage node is split on number of comorbid conditions, with 0 to the left and 1 or more to the right. In these data, of those to be "salvage" but to have none of the listed comorbid conditions, only 11 of 52 died; of those who had any of the listed comorbidities, 52 of 110 died in–hospital. These last two nodes are boxed, indicating that there are further splits below this level, but we abridge the tree at this point since those splits are less important in improving overall tree fit than the splits shown elsewhere on the page.

In contrast to the “Salvage with some comorbid condition” node, notice that of the almost 6,600 patients who had elective or urgent acuity, were under age 67, had either no or only one comorbid condition, creatinine levels that were not too elevated, fairly normal ejection

[16] In this tree, homogeneity is measured by the deviance, which is closely related to the likelihood function; also commonly used in tree splitting is the misclassification rate. Of course, the exact split depends on the criterion but the qualitative conclusions we draw in this section do not.

FIGURE F-1: 1997-1998 CCMRP Isolated CABG Summary, Multivariate Classification Tree



EF: Ejection Fraction
LM: Stenosis of Left Main
MI: MI prior to CABG
OP: Operative incidence
CoMorbid: Comorbidities include Diabetes, Dialysis, Peripheral Vascular Disease, Cerebrovascular Disease, COPD, and Ventricular Arrhythmia
x/y : branches below this point continue, but are truncated to simplify structure

fraction, and low CHF category, only 21 died. Answers to only six questions (acuity, age, number of comorbidities, creatinine, ejection fraction, and CHF class) could be used to identify a group of patients comprising more than a fifth of the entire data set whose overall mortality rate was 0.3%, i.e., 99.7% of them survived to be discharged from the hospital.

A tree–based model like the one shown here could be used as the basis for a risk–adjustment model, but because statistical inference for tree–based models is still in its infancy it would be premature to do so. Rather, the tree serves as a particularly easy–to–grasp summary of the data. Not only does it provide a good sense of the importance of interaction among variables (for example, the tree suggests that congestive heart failure has more severe implications for older patients than it does for younger patients), but it also points out that the majority of CABG patients fall into relatively few risk "boxes" with very low probabilities of death. Although the mean in–hospital death rate in our data set is 2.60%, one can determine from the tree that the median risk of death for CABG patients is approximately 0.7%, which coincides with our previous estimate based on the logistic regression model. Happily, in California today the vast majority of CABG surgery cases are very low risk.

Hospital Risk–Adjusted Mortality Predictions

The logistic regression model in the previous section can be used to risk–adjust the observations collected from the 82 hospitals by calculating expected numbers of in-hospital deaths and comparing them to the observed numbers of deaths.[17] Tables F–6 and F–7 below show this comparison, arranging the hospitals first in alphabetical order, then in descending order of O/E ratio. Four hospitals show an observed death rate higher than the upper bound of the 95% confidence interval and thus are labeled as "Worse than expected," and three lower than the lower bound and are labeled "Better than expected."

To read this table, look at the observed to expected mortality ratio (O/E). If this number is higher than 1.0, it means that the hospital had more deaths than would have been expected given the health status of its patients. If the number is lower than 1.0, it means that the hospital had fewer deaths than would have been expected given the health status of its patients. However, **small differences in the O/E ratio are usually not significant**. The most important issue is that hospitals that have O/E ratios of less than or greater than one do not necessarily do better or worse than expected unless the result is statistically significant. Those hospitals where the difference between observed and expected death rates are significantly different are shown in bold type.

Total CABG cases submitted: This column reports the number of isolated CABG cases submitted to CCMRP for the 1997–1998 period. Some hospitals began submitting data to us in 1997, while others began in 1998, so we include the starting and ending dates for the data we received. Staff combined all data from all participating hospitals to construct our 1997–1998 risk adjustment model. The 1997–1998 data set for public reporting has almost 28,597 cases in it from 79 hospitals, making this report the largest ever public report on CABG outcomes.

[17] Three of the 82 Hospitals that submitted data for the 1997-1998 period withdrew from the program after the analysis was completed but prior to preparation of the report, leaving 79 hospitals that agreed to publicity report their results. However, data from all 82 hospitals was used to develop the risk-adjustment model.

The number of observed deaths: These are the actual number of in–hospital deaths submitted to CCMRP for isolated CABG patients during the 1997–1998 period. This number does *not* include patients who died after transfer or discharge from a hospital. There were 802 in–hospital deaths in our 1997–1998 risk–adjustment data set.

The number of expected deaths: The risk adjustment model was used to calculate the probability of in–hospital death for each one of the 30,800 cases (82 hospitals) in the 1997–1998 data set used to derive the risk–adjustment model. CCMRP staff then summed the probabilities for all cases at each hospital to get the number of in–hospital deaths we would expect given the case–mix of patient severities. For example, if a hospital had 150 patients, 100 of whom had a 1% probability of death, 40 of whom had a 4% probability of death, and 10 with a 9% probability of death, the total number of expected deaths would be 3.5 (i.e., (100)(1%) + (40)(4%) + (10)(9%) = 1 + 1.6 + 0.9 = 3.5 expected deaths). Note that the number of expected deaths can be a fractional number, unlike the number of observed deaths (which can only be a whole number).

The observed and expected death rates: Dividing the number of observed deaths for each hospital by the total number of cases produces the observed death rate for the 1997–1998 period. Dividing the number of expected deaths by the total number of cases produces the expected death rate. For example, if a hospital had 250 isolated CABG cases in 1997–1998, with seven actual in–hospital deaths, and an expected number of in–hospital deaths of 8.2, the observed death rate would be 7/250 = 2.8% while the expected death rate would be 8.2/250 = 3.28%. Note that the expected death rate is a measure of the average severity of illness of isolated CABG patients at a particular hospital: the higher the expected rate, the higher the average severity. The average death rate for the entire 1997–1998 data set is 802/30814 = 2.60%, so if the expected death rate is higher than 2.60% at a particular hospital, their isolated CABG patients tend to be higher risk than the overall population of CABG patients in our study.

The lower and upper bounds on the expected death rate: Assuming that the CCMRP risk adjustment model is correct, we can calculate the standard deviation of the number of expected deaths at each hospital. Because there is a great deal of variability in patient risks, the standard deviation is calculated based on the predictions of risk for each patient rather than using the average risk over all patients at each hospital. A lower confidence limit bound is calculated on our expected rate by subtracting twice the standard deviation from our expected rate, and a similar upper bound by adding twice the standard deviation to our expected rate. Two standard deviations (2SD) below and above the expected rate is an approximate 95% confidence interval. In general, when the upper and lower bounds on the expected death rate are close together, that means that the expected rate is fairly reliably estimated. **The width of the confidence interval depends both on the number of cases that a hospital submitted to us, and how widely differing the risks are for their isolated CABG patients.** A hospital that submitted many cases to the CCMRP will tend to have a narrower confidence interval than a hospital that did not, and the CCMRP will tend to have a more reliable idea of its overall performance.

The O/E ratio: The ratio of the observed to expected death rates produces the O/E ratio. This ratio is a quick method for assessing hospital performance. If a hospital had fewer actual

deaths than expected, its O/E ratio will be less than 1.0. If a hospital had more deaths than expected, its O/E ratio will be greater than 1.0. If, as in the previous example, the observed death rate was 2.8% while the expected death rate was 3.28%, the O/E ratio would be 2.8%/3.28% = 0.854.

Overall rating: The overall rating is a combination of overall performance (given by the O/E ratio) and how reliable that performance is (given by the lower and upper bounds on the expected death rate). All hospitals were split into three groups, "better than expected," "worse than expected," and "no different than expected." If a hospital's O/E ratio is less than one *and* its observed death rate is below the lower bound on the expected death rate, it means that CCMRP staff calculated its performance to be better than expected *and* we are fairly confident that our calculation was reliable. On the other hand, if a hospital's O/E ratio is greater than one *and* its observed death rate is above the upper bound on the expected death rate, it is rated as "worse than expected." If a hospital's observed rate is within the 2SD confidence interval, it means that we cannot reliably assign it to one of the other two groupings and it will be listed as "no different than expected."

Table F–6: Risk–Adjusted Results for CCMRP Hospitals, 1997–1998, Sorted Alphabetically

Name	Total CABG Cases Submitted	Number of Observed Deaths	Number of Expected Deaths	O/E Ratio	Observed Death Rate (%)	Lower 95% CI of Expected Death Rate (%)	Expected Death Rate (%)	Upper 95% CI of Expected Death Rate (%)	Overall Performance Rating (blank = no different than expected)
ALTA BATES MEDICAL CENTER	276	11	7.29	1.51	3.99	0.83	2.64	4.46	
ALVARADO HOSPITAL MEDICAL CENTER	298	16	10.71	1.49	5.37	1.51	3.59	5.68	
ANAHEIM MEMORIAL MEDICAL CENTER	130	4	3.08	1.30	3.08	0.00	2.37	4.89	
CALIFORNIA PAC MED CTR—PACIFIC CAMPUS	176	6	3.47	1.73	3.41	0.00	1.97	4.03	
CEDARS–SINAI MEDICAL CENTER	868	19	21.54	0.88	2.19	1.46	2.48	3.50	
CITRUS VALLEY MEDICAL CENTER–IC CAMPUS	430	16	14.35	1.12	3.72	1.65	3.34	5.03	
COMMUNITY MEM HOSP—SAN BUENAVENTURA	202	4	3.81	1.05	1.98	0.00	1.89	3.78	
DAMERON HOSPITAL	107	3	3.97	0.76	2.80	0.30	3.71	7.11	
DANIEL FREEMAN MEMORIAL HOSPITAL	173	2	3.86	0.52	1.16	0.01	2.23	4.44	
DESERT REGIONAL MEDICAL CENTER	122	5	2.91	1.72	4.10	0.00	2.39	5.12	
DOCTORS MEDICAL CENTER—SAN PABLO	169	3	7.28	0.41	1.78	1.42	4.31	7.21	
DOCTORS MEDICAL CENTER—MODESTO	451	11	8.22	1.34	2.44	0.57	1.82	3.07	
DOMINICAN SANTA CRUZ HOSPITAL—SOQUEL	272	10	7.84	1.28	3.68	0.98	2.88	4.79	
DOWNEY COMMUNITY HOSPITAL ▼	239	13	6.53	1.99	5.44	0.72	2.73	4.75	Worse than Expected
EL CAMINO HOSPITAL	52	1	2.14	0.47	1.92	0.00	4.11	8.96	
ENCINO TARZANA REGIONAL MEDICAL CENTER	145	2	7.17	0.28	1.38	1.36	4.94	8.53	
GLENDALE ADVENTIST MEDICAL CENTER	203	7	6.35	1.10	3.45	0.83	3.13	5.43	
GLENDALE MEMORIAL HOSPITAL AND HEALTH CTR	223	8	10.98	0.73	3.59	2.13	4.92	7.72	
GRANADA HILLS COMMUNITY HOSPITAL	142	4	2.13	1.88	2.82	0.00	1.50	3.52	
HOAG MEMORIAL HOSPITAL PRESBYTERIAN ★	496	9	17.98	0.50	1.81	2.03	3.63	5.22	Better than Expected
JOHN MUIR MEDICAL CENTER ▼	128	9	2.97	3.03	7.03	0.00	2.32	4.91	Worse than Expected
KAISER FOUNDATION HOSP—GEARY (S.F.)	992	21	18.58	1.13	2.12	1.05	1.87	2.69	
KAISER FOUNDATION HOSP—SUNSET (L.A.)	2302	31	37.66	0.82	1.35	1.12	1.64	2.15	
KAWEAH DELTA DISTRICT HOSPITAL	562	9	16.51	0.55	1.60	1.59	2.94	4.28	
LANCASTER COMMUNITY HOSPITAL	23	0	0.76	0.00	0.00	0.00	3.31	9.49	
LITTLE COMPANY OF MARY HOSPITAL	160	4	3.84	1.04	2.50	0.03	2.40	4.77	

★ Better than expected mortality rate, ▼ Worse than expected mortality rate.

Table F–6: Risk–Adjusted Results for CCMRP Hospitals, 1997–1998, Sorted Alphabetically

Name	Total CABG Cases Submitted	Number of Observed Deaths	Number of Expected Deaths	O/E Ratio	Observed Death Rate (%)	Lower 95% CI of Expected Death Rate (%)	Expected Death Rate (%)	Upper 95% CI of Expected Death Rate (%)	Overall Performance Rating (blank = no different than expected)
LONG BEACH MEMORIAL MEDICAL CENTER	378	7	12.01	0.58	1.85	1.42	3.18	4.93	
LOS ANGELES CO USC MEDICAL CENTER	146	4	2.87	1.39	2.74	0.00	1.96	4.20	
MARIN GENERAL HOSPITAL	94	2	1.74	1.15	2.13	0.00	1.85	4.59	
MEDICAL CENTER AT THE UCSF	141	7	3.95	1.77	4.96	0.29	2.80	5.30	
MEMORIAL HOSPITAL MODESTO	550	16	11.55	1.39	2.91	0.89	2.10	3.31	
MERCY GENERAL HOSPITAL	2565	32	38.37	0.83	1.25	1.03	1.50	1.97	
MERCY MEDICAL CENTER—REDDING	114	3	5.49	0.55	2.63	1.05	4.82	8.58	
MERCY SAN JUAN HOSPITAL ▼	408	17	7.92	2.15	4.17	0.60	1.94	3.28	Worse than Expected
METHODIST HOSPITAL OF SOUTHERN CALIFORNIA	428	17	14.26	1.19	3.97	1.64	3.33	5.02	
MILLS–PENINSULA MEDICAL CENTER	323	14	8.92	1.57	4.33	1.04	2.76	4.48	
MT DIABLO MEDICAL CENTER	561	20	15.91	1.26	3.57	1.49	2.84	4.18	
NORTHRIDGE HOSPITAL MEDICAL CENTER	301	9	8.91	1.01	2.99	1.04	2.96	4.88	
PALOMAR MEDICAL CENTER	349	13	11.08	1.17	3.72	1.40	3.18	4.95	
POMONA VALLEY HOSPITAL MEDICAL CENTER	527	18	13.11	1.37	3.42	1.19	2.49	3.79	
PRESBYTERIAN INTERCOMMUNITY HOSPITAL ▼	117	9	4.55	1.98	7.69	0.69	3.89	7.08	Worse than Expected
PROVIDENCE HOLY CROSS MEDICAL CENTER	114	3	2.70	1.11	2.63	0.00	2.37	5.19	
PROVIDENCE SAINT JOSEPH MEDICAL CENTER	232	3	3.74	0.80	1.29	0.00	1.61	3.25	
REDDING MEDICAL CENTER	1037	14	16.22	0.86	1.35	0.81	1.56	2.32	
RIVERSIDE COMMUNITY HOSPITAL	86	7	4.57	1.53	8.14	1.00	5.32	9.64	
SADDLEBACK MEMORIAL MEDICAL CENTER	175	9	8.03	1.12	5.14	1.52	4.59	7.66	
SALINAS VALLEY MEMORIAL HOSPITAL	135	2	3.88	0.52	1.48	0.08	2.87	5.67	
SAN ANTONIO COMMUNITY HOSPITAL	124	3	7.56	0.40	2.42	2.25	6.10	9.94	
SANTA BARBARA COTTAGE HOSPITAL	267	9	6.75	1.33	3.37	0.65	2.53	4.41	
SANTA MONICA—UCLA MEDICAL CENTER	45	2	1.25	1.60	4.44	0.00	2.78	7.64	
SCRIPPS MEMORIAL HOSPITAL—LA JOLLA	674	15	19.92	0.75	2.23	1.74	2.96	4.17	

★ Better than expected mortality rate, ▼ Worse than expected mortality rate.

Table F–6: Risk–Adjusted Results for CCMRP Hospitals, 1997–1998, Sorted Alphabetically

Name	Total CABG Cases Submitted	Number of Observed Deaths	Number of Expected Deaths	O/E Ratio	Observed Death Rate (%)	Lower 95% CI of Expected Death Rate (%)	Expected Death Rate (%)	Upper 95% CI of Expected Death Rate (%)	Overall Performance Rating (blank = no different than expected)
SEQUOIA HOSPITAL	483	18	21.36	0.84	3.73	2.67	4.42	6.18	
SETON MEDICAL CENTER	1249	18	22.21	0.81	1.44	1.04	1.78	2.52	
SHARP CHULA VISTA MEDICAL CENTER	531	23	18.94	1.21	4.33	2.01	3.57	5.12	
SHARP GROSSMONT HOSPITAL	133	1	2.34	0.43	0.75	0.00	1.76	4.02	
SHARP MEMORIAL HOSPITAL	304	4	5.24	0.76	1.32	0.25	1.73	3.20	
ST. BERNARDINE MEDICAL CENTER	405	11	14.40	0.76	2.72	1.76	3.56	5.35	
ST. FRANCIS MEDICAL CENTER	62	3	3.39	0.89	4.84	0.00	5.46	11.00	
ST. HELENA HOSPITAL AND HEALTH CENTER	419	8	11.27	0.71	1.91	1.15	2.69	4.23	
ST. JOHN'S HOSPITAL—SANTA MONICA	256	5	6.80	0.74	1.95	0.72	2.66	4.60	
ST. JOHN'S REGIONAL MED CENTER – OXNARD	90	2	2.91	.69	2.22	0.00	3.24	6.84	
ST. JOSEPH HOSPITAL—ORANGE	293	8	6.57	1.22	2.73	0.54	2.24	3.94	
ST. JOSEPH'S MEDICAL CENTER OF STOCKTON	610	20	17.31	1.16	3.28	1.55	2.84	4.13	
ST. JUDE MEDICAL CENTER	205	8	5.13	1.56	3.90	0.40	2.50	4.61	
ST. MARY MEDICAL CENTER—LONG BEACH	87	7	5.82	1.20	8.05	1.60	6.69	11.78	
ST. VINCENT MEDICAL CENTER	74	2	2.14	0.93	2.70	0.00	2.89	6.65	
STANFORD UNIVERSITY HOSPITAL	269	10	6.23	1.61	3.72	0.51	2.31	4.12	
SUMMIT MEDICAL CENTER ★	325	5	11.85	0.42	1.54	1.73	3.65	5.57	Better than Expected
SUTTER MEMORIAL HOSPITAL ★	1534	25	42.71	0.59	1.63	1.99	2.78	3.58	Better than Expected
THE HEART HOSPITAL, INC.	133	1	3.58	0.28	0.75	0.00	2.69	5.39	
TORRANCE MEMORIAL MEDICAL CENTER	401	20	16.72	1.20	4.99	2.33	4.17	6.01	
TRI–CITY MEDICAL CENTER	431	7	10.31	0.68	1.62	0.97	2.39	3.82	
UCLA MEDICAL CENTER	191	7	6.10	1.15	3.66	0.81	3.19	5.57	
UC SAN DIEGO UNIVERSITY MEDICAL CENTER (THORNTON AND HILLCREST)	191	9	7.39	1.22	4.71	1.17	3.87	6.57	
UCSF/MT ZION	44	2	1.40	1.43	4.55	0.00	3.18	8.40	
UNIVERSITY OF CALIFORNIA DAVIS MEDICAL CENTER	74	2	1.62	1.23	2.70	0.00	2.19	5.52	

★ Better than expected mortality rate, ▼ Worse than expected mortality rate.

Table F–6: Risk–Adjusted Results for CCMRP Hospitals, 1997–1998, Sorted Alphabetically

Name	Total CABG Cases Submitted	Number of Observed Deaths	Number of Expected Deaths	O/E Ratio	Observed Death Rate (%)	Lower 95% CI of Expected Death Rate (%)	Expected Death Rate (%)	Upper 95% CI of Expected Death Rate (%)	Overall Performance Rating (blank = no different than expected)
UNIVERSITY OF CALIFORNIA IRVINE MED CTR	94	0	3.13	0.00	0.00	0.00	3.33	6.89	
USC UNIVERSITY HOSPITAL	144	4	2.74	1.46	2.78	0.00	1.90	4.15	
WASHINGTON HOSPITAL—FREMONT	334	14	17.07	0.82	4.19	2.92	5.11	7.30	

★ Better than expected mortality rate, ▼ Worse than expected mortality rate.

Table F–7: Risk–Adjusted Results for CCMRP Hospitals, 1997–1998, Sorted by O/E Ratio

Name	Total CABG Cases Submitted	Number of Observed Deaths	Number of Expected Deaths	O/E Ratio	Observed Death Rate (%)	Lower 95% CI of Expected Death Rate (%)	Expected Death Rate (%)	Upper 95% CI of Expected Death Rate (%)	Overall Performance Rating (blank = no different than expected)
LANCASTER COMMUNITY HOSPITAL	23	0	0.76	0.00	0.00	0.00	3.31	9.49	
UNIVERSITY OF CALIFORNIA IRVINE MED CTR	94	0	3.13	0.00	0.00	0.00	3.33	6.89	
ENCINO TARZANA REGIONAL MEDICAL CENTER	145	2	7.17	0.28	1.38	1.36	4.94	8.53	
THE HEART HOSPITAL, INC.	133	1	3.58	0.28	0.75	0.00	2.69	5.39	
SAN ANTONIO COMMUNITY HOSPITAL	124	3	7.56	0.40	2.42	2.25	6.10	9.94	
DOCTORS MEDICAL CENTER—SAN PABLO	169	3	7.28	0.41	1.78	1.42	4.31	7.21	
SUMMIT MEDICAL CENTER ★	325	5	11.85	0.42	1.54	1.73	3.65	5.57	Better than Expected
SHARP GROSSMONT HOSPITAL	133	1	2.34	0.43	0.75	0.00	1.76	4.02	
EL CAMINO HOSPITAL	52	1	2.14	0.47	1.92	0.00	4.11	8.96	
HOAG MEMORIAL HOSPITAL PRESBYTERIAN ★	496	9	17.98	0.50	1.81	2.03	3.63	5.22	Better than Expected
SALINAS VALLEY MEMORIAL HOSPITAL	135	2	3.88	0.52	1.48	0.08	2.87	5.67	
DANIEL FREEMAN MEMORIAL HOSPITAL	173	2	3.86	0.52	1.16	0.01	2.23	4.44	
KAWEAH DELTA DISTRICT HOSPITAL	562	9	16.51	0.55	1.60	1.59	2.94	4.28	
MERCY MEDICAL CENTER–REDDING	114	3	5.49	0.55	2.63	1.05	4.82	8.58	
LONG BEACH MEMORIAL MEDICAL CENTER	378	7	12.01	0.58	1.85	1.42	3.18	4.93	
SUTTER MEMORIAL HOSPITAL ★	1534	25	42.71	0.59	1.63	1.99	2.78	3.58	Better than Expected
TRI–CITY MEDICAL CENTER	431	7	10.31	0.68	1.62	0.97	2.39	3.82	
ST. JOHN'S REGIONAL MED CENTER – OXNARD	90	2	2.91	0.69	2.22	0.00	3.24	6.84	
ST. HELENA HOSPITAL AND HEALTH CENTER	419	8	11.27	0.71	1.91	1.15	2.69	4.23	
GLENDALE MEM HOSPITAL AND HEALTH CENTER	223	8	10.98	0.73	3.59	2.13	4.92	7.72	
ST. JOHN'S HOSPITAL—SANTA MONICA	256	5	6.80	0.74	1.95	0.72	2.66	4.60	
SCRIPPS MEMORIAL HOSPITAL—LA JOLLA	674	15	19.92	0.75	2.23	1.74	2.96	4.17	
DAMERON HOSPITAL	107	3	3.97	0.76	2.80	0.30	3.71	7.11	
SHARP MEMORIAL HOSPITAL	304	4	5.24	0.76	1.32	0.25	1.73	3.20	
ST. BERNARDINE MEDICAL CENTER	405	11	14.40	0.76	2.72	1.76	3.56	5.35	

★ Better than expected mortality rate, ▼ Worse than expected mortality rate.

Table F–7: Risk–Adjusted Results for CCMRP Hospitals, 1997–1998, Sorted by O/E Ratio

Name	Total CABG Cases Submitted	Number of Observed Deaths	Number of Expected Deaths	O/E Ratio	Observed Death Rate (%)	Lower 95% CI of Expected Death Rate (%)	Expected Death Rate (%)	Upper 95% CI of Expected Death Rate (%)	Overall Performance Rating (blank = no different than expected)
PROVIDENCE SAINT JOSEPH MEDICAL CENTER	232	3	3.74	0.80	1.29	0.00	1.61	3.25	
SETON MEDICAL CENTER	1249	18	22.21	0.81	1.44	1.04	1.78	2.52	
WASHINGTON HOSPITAL—FREMONT	334	14	17.07	0.82	4.19	2.92	5.11	7.30	
KAISER FOUNDATION HOSP—SUNSET (L.A.)	2302	31	37.66	0.82	1.35	1.12	1.64	2.15	
MERCY GENERAL HOSPITAL	2565	32	38.37	0.83	1.25	1.03	1.50	1.97	
SEQUOIA HOSPITAL	483	18	21.36	0.84	3.73	2.67	4.42	6.18	
REDDING MEDICAL CENTER	1037	14	16.22	0.86	1.35	0.81	1.56	2.32	
CEDARS–SINAI MEDICAL CENTER	868	19	21.54	0.88	2.19	1.46	2.48	3.50	
ST. FRANCIS MEDICAL CENTER	62	3	3.39	0.89	4.84	0.00	5.46	11.00	
ST. VINCENT MEDICAL CENTER	74	2	2.14	0.93	2.70	0.00	2.89	6.65	
NORTHRIDGE HOSPITAL MEDICAL CENTER	301	9	8.91	1.01	2.99	1.04	2.96	4.88	
LITTLE COMPANY OF MARY HOSPITAL	160	4	3.84	1.04	2.50	0.03	2.40	4.77	
COMMUNITY MEM HOSP—SAN BUENAVENTURA	202	4	3.81	1.05	1.98	0.00	1.89	3.78	
GLENDALE ADVENTIST MEDICAL CENTER	203	7	6.35	1.10	3.45	0.83	3.13	5.43	
PROVIDENCE HOLY CROSS MEDICAL CENTER	114	3	2.70	1.11	2.63	0.00	2.37	5.19	
CITRUS VALLEY MEDICAL CENTER—IC CAMPUS	430	16	14.35	1.12	3.72	1.65	3.34	5.03	
SADDLEBACK MEMORIAL MEDICAL CENTER	175	9	8.03	1.12	5.14	1.52	4.59	7.66	
KAISER FOUNDATION HOSP—GEARY (S.F.)	992	21	18.58	1.13	2.12	1.05	1.87	2.69	
UCLA MEDICAL CENTER	191	7	6.10	1.15	3.66	0.81	3.19	5.57	
MARIN GENERAL HOSPITAL	94	2	1.74	1.15	2.13	0.00	1.85	4.59	
ST. JOSEPH'S MEDICAL CENTER OF STOCKTON	610	20	17.31	1.16	3.28	1.55	2.84	4.13	
PALOMAR MEDICAL CENTER	349	13	11.08	1.17	3.72	1.40	3.18	4.95	
METHODIST HOSPITAL OF SOUTHERN CALIFORNIA	428	17	14.26	1.19	3.97	1.64	3.33	5.02	
TORRANCE MEMORIAL MEDICAL CENTER	401	20	16.72	1.20	4.99	2.33	4.17	6.01	
ST. MARY MEDICAL CENTER—LONG BEACH	87	7	5.82	1.20	8.05	1.60	6.69	11.78	

★ Better than expected mortality rate, ▼ Worse than expected mortality rate.

Table F–7: Risk–Adjusted Results for CCMRP Hospitals, 1997–1998, Sorted by O/E Ratio

Name	Total CABG Cases Submitted	Number of Observed Deaths	Number of Expected Deaths	O/E Ratio	Observed Death Rate (%)	Lower 95% CI of Expected Death Rate (%)	Expected Death Rate (%)	Upper 95% CI of Expected Death Rate (%)	Overall Performance Rating (blank = no different than expected)
SHARP CHULA VISTA MEDICAL CENTER	531	23	18.94	1.21	4.33	2.01	3.57	5.12	
UCSD/SAN DIEGO—UNIVERSITY MEDICAL CTR	191	9	7.39	1.22	4.71	1.17	3.87	6.57	
ST. JOSEPH HOSPITAL—ORANGE	293	8	6.57	1.22	2.73	0.54	2.24	3.94	
UNIVERSITY OF CALIFORNIA DAVIS MED CTR	74	2	1.62	1.23	2.70	0.00	2.19	5.52	
MT DIABLO MEDICAL CENTER	561	20	15.91	1.26	3.57	1.49	2.84	4.18	
DOMINICAN SANTA CRUZ HOSPITAL – SOQUEL	272	10	7.84	1.28	3.68	0.98	2.88	4.79	
ANAHEIM MEMORIAL MEDICAL CENTER	130	4	3.08	1.30	3.08	0.00	2.37	4.89	
SANTA BARBARA COTTAGE HOSPITAL	267	9	6.75	1.33	3.37	0.65	2.53	4.41	
DOCTORS MEDICAL CENTER —MODESTO	451	11	8.22	1.34	2.44	0.57	1.82	3.07	
POMONA VALLEY HOSPITAL MEDICAL CENTER	527	18	13.11	1.37	3.42	1.19	2.49	3.79	
MEMORIAL HOSPITAL MODESTO	550	16	11.55	1.39	2.91	0.89	2.10	3.31	
LOS ANGELES CO USC MEDICAL CENTER	146	4	2.87	1.39	2.74	0.00	1.96	4.20	
UCSF/MT ZION	44	2	1.40	1.43	4.55	0.00	3.18	8.40	
USC UNIVERSITY HOSPITAL	144	4	2.74	1.46	2.78	0.00	1.90	4.15	
ALVARADO HOSPITAL MEDICAL CENTER	298	16	10.71	1.49	5.37	1.51	3.59	5.68	
ALTA BATES MEDICAL CENTER	276	11	7.29	1.51	3.99	0.83	2.64	4.46	
RIVERSIDE COMMUNITY HOSPITAL	86	7	4.57	1.53	8.14	1.00	5.32	9.64	
ST. JUDE MEDICAL CENTER	205	8	5.13	1.56	3.90	0.40	2.50	4.61	
MILLS–PENINSULA MEDICAL CENTER	323	14	8.92	1.57	4.33	1.04	2.76	4.48	
SANTA MONICA—UCLA MEDICAL CENTER	45	2	1.25	1.60	4.44	0.00	2.78	7.64	
STANFORD UNIVERSITY HOSPITAL	269	10	6.23	1.61	3.72	0.51	2.31	4.12	
DESERT REGIONAL MEDICAL CENTER	122	5	2.91	1.72	4.10	0.00	2.39	5.12	
CALIFORNIA PAC MED CTR–PACIFIC CAMPUS	176	6	3.47	1.73	3.41	0.00	1.97	4.03	
MEDICAL CENTER AT THE UCSF	141	7	3.95	1.77	4.96	0.29	2.80	5.30	
GRANADA HILLS COMMUNITY HOSPITAL	142	4	2.13	1.88	2.82	0.00	1.50	3.52	
PRESBYTERIAN INTERCOMMUNITY HOSPITAL ▼	117	9	4.55	1.98	7.69	0.69	3.89	7.08	Worse than Expected
DOWNEY COMMUNITY HOSPITAL ▼	239	13	6.53	1.99	5.44	0.72	2.73	4.75	Worse than Expected
MERCY SAN JUAN HOSPITAL ▼	408	17	7.92	2.15	4.17	0.60	1.94	3.28	Worse than Expected
JOHN MUIR MEDICAL CENTER ▼	128	9	2.97	3.03	7.03	0.00	2.32	4.91	Worse than Expected

★ Better than expected mortality rate, ▼ Worse than expected mortality rate.

APPENDIX G: UNIVARIATE DATA SUMMARIES

Tables G–1 to G–8 describe the completeness of data received for analysis and variations in coding practices among hospitals:

Table G–1: Cases with number of missing data elements

Table G–2: Percent of missing by data element, all cases

Table G–3: Percent of total data elements missing, sorted alphabetically by hospital

Table G–4: Percent of total data elements missing, sorted by % missing for each hospital

Table G–5: Distribution of comorbidities by hospital, sorted by 3+ comorbidities

Table G–6: Distribution of acuity variable by hospital, sorted by emergent

Table G–7: Distribution of ejection fraction variable by hospital, sorted by <30

Table G–8: Hospital coding practices of data elements in risk-adjustment model

Table G-1: Cases with Number of Missing Data Elements

Number of Elements Missing	Frequency of Cases	Percent of Cases	Cumulative
0	1,463	5.1	5.1
1	4,901	17.1	22.3
2	5,477	19.2	41.4
3	7,142	25.0	66.4
4	5,700	19.9	86.3
5	2,726	9.5	95.9
6	622	2.2	98.0
7	318	1.1	99.1
8	94	0.3	99.5
9	45	0.2	99.6
10	39	0.1	99.8
11	19	0.1	99.8
12	18	0.1	99.9
13	16	0.1	99.9
14	10	0.0	100.0
15	4	0.0	100.0
16	2	0.0	100.0
18	1	0.0	100.0
Total	28,597	100.0	

Table G-2: Percent of Missing by Data Element, All Cases

Variable	Missing	Not Missing	Total	% Missing
Acuity	451	28,146	28,597	1.6
Age	11	28,586	28,597	0.0
Angina	136	28,461	28,597	0.5
CCS Class	1,710	26,887	28,597	6.0
Cerebrovascular Disease	1,716	26,881	28,597	6.0
COPD	138	28,459	28,597	0.5
Creatinine	8,828	19,769	28,597	30.9
Diabetes	137	28,460	28,597	0.5
Dialysis	3,979	24,618	28,597	13.9
Diseased Vessels	118	28,479	28,597	0.4
Ejection Fraction	2,601	25,996	28,597	9.1
Hypertension	80	28,517	28,597	0.3
Left Main Stenosis	18,049	10,548	28,597	63.1
Mitral Insufficiency	18,699	9,898	28,597	65.4
Myocardial Infarction	242	28,355	28,597	0.8
No. of Operations	—	28,597	28,597	0.0
NYHA Class	2,956	25,641	28,597	10.3
Peripheral Vascular Disease	114	28,483	28,597	0.4
PTCA	16,105	12,492	28,597	56.3
Race	187	28,410	28,597	0.7
Sex	17	28,580	28,597	0.1
Status	69	28,528	28,597	0.2
Ventricular Arrhythmia	5,756	22,841	28,597	20.1

Table G-3: Percent of Total Data Elements Missing, Sorted Alphabetically by Hospital

Hospital	Number of Cases	Missing Data Elements	Total Data Elements	% Missing
ALTA BATES MEDICAL CENTER	276	1,040	6,348	16.4%
ALVARADO HOSPITAL MEDICAL CENTER	298	841	6,854	12.3%
ANAHEIM MEMORIAL MEDICAL CENTER	130	91	2,990	3.0%
CALIFORNIA PAC MED CTR—PACIFIC CAMPUS	176	388	4,048	9.6%
CEDARS–SINAI MEDICAL CENTER	868	1,477	19,964	7.4%
CITRUS VALLEY MEDICAL CENTER—IC CAMPUS	430	1,164	9,890	11.8%
COMMUNITY MEM HOSP—SAN BUENAVENTURA	202	715	4,646	15.4%
DAMERON HOSPITAL	107	78	2,461	3.2%
DANIEL FREEMAN MEMORIAL HOSPITAL	173	423	3,979	10.6%
DESERT REGIONAL MEDICAL CENTER	122	141	2,806	5.0%
DOCTORS MEDICAL CENTER—MODESTO	451	3,360	10,373	32.4%
DOCTORS MEDICAL CENTER—SAN PABLO	169	410	3,887	10.5%
DOMINICAN SANTA CRUZ HOSPITAL—SOQUEL	272	861	6,256	13.8%
DOWNEY COMMUNITY HOSPITAL ▼	239	1,086	5,497	19.8%
EL CAMINO HOSPITAL	52	51	1,196	4.3%
ENCINO TARZANA REGIONAL MEDICAL CENTER	145	267	3,335	8.0%
GLENDALE ADVENTIST MEDICAL CENTER	203	553	4,669	11.8%
GLENDALE MEMORIAL HOSPITAL AND HEALTH CTR	223	1,282	5,129	25.0%
GRANADA HILLS COMMUNITY HOSPITAL	142	167	3,266	5.1%
GROSSMONT HOSPITAL (SHARP)	133	348	3,059	11.4%
HOAG MEMORIAL HOSPITAL PRESBYTERIAN ★	496	379	11,408	3.3%
JOHN MUIR MEDICAL CENTER ▼	128	111	2,944	3.8%
KAISER FOUNDATION HOSPITAL—GEARY (S.F.)	992	4,215	22,816	18.5%
KAISER FOUNDATION HOSPITAL—SUNSET	2,302	8,102	52,923	15.3%
KAWEAH DELTA DISTRICT HOSPITAL	562	1,628	12,926	12.6%
LANCASTER COMMUNITY HOSPITAL	23	16	529	3.0%
LITTLE COMPANY OF MARY HOSPITAL	160	496	3,680	13.5%
LONG BEACH MEMORIAL MEDICAL CENTER	378	996	8,694	11.5%
LOS ANGELES CO USC MEDICAL CENTER	146	555	3,358	16.5%
MARIN GENERAL HOSPITAL	94	293	2,162	13.6%
MEDICAL CENTER AT THE UCSF	141	226	3,243	7.0%
MEMORIAL HOSPITAL MODESTO	550	505	12,650	4.0%
MERCY GENERAL HOSPITAL	2,565	10,410	58,995	17.6%
MERCY MEDICAL CENTER—REDDING	114	96	2,622	3.7%
MERCY SAN JUAN HOSPITAL ▼	408	1,535	9,384	16.4%
METHODIST HOSPITAL OF SOUTHERN CAL	428	1,130	9,844	11.5%
MILLS—PENINSULA MEDICAL CENTER	323	1,382	7,429	18.6%
MT DIABLO MEDICAL CENTER	561	1,942	12,903	15.1%
NORTHRIDGE HOSPITAL MEDICAL CENTER	301	1,194	6,923	17.2%
PALOMAR MEDICAL CENTER	349	795	8,027	9.9%

★ Better than expected mortality rate, ▼ Worse than expected mortality rate.

Table G-3: Percent of Total Data Elements Missing, Sorted Alphabetically by Hospital (cont.)

Hospital	Number of Cases	Missing Data Elements	Total Data Elements	% Missing
POMONA VALLEY HOSPITAL MEDICAL CENTER	527	2,374	12,121	19.6%
PRESBYTERIAN INTERCOMMUNITY HOSPITAL ▼	117	419	2,691	15.6%
PROVIDENCE HOLY CROSS MEDICAL CENTER	114	101	2,622	3.9%
PROVIDENCE SAINT JOSEPH MEDICAL CENTER	232	315	5,336	5.9%
REDDING MEDICAL CENTER	1,037	3,134	23,851	13.1%
RIVERSIDE COMMUNITY HOSPITAL	86	232	1,978	11.7%
SADDLEBACK MEMORIAL MEDICAL CENTER	175	361	4,025	9.0%
SALINAS VALLEY MEMORIAL HOSPITAL	135	96	3,105	3.1%
SAN ANTONIO COMMUNITY HOSPITAL	124	509	2,852	17.8%
SANTA BARBARA COTTAGE HOSPITAL	267	738	6,141	12.0%
SANTA MONICA—UCLA MEDICAL CENTER	45	69	1,035	6.7%
SCRIPPS MEMORIAL HOSPITAL—LA JOLLA	674	674	15,502	4.3%
SEQUOIA HOSPITAL	483	1,086	11,109	9.8%
SETON MEDICAL CENTER	1,249	1,097	28,727	3.8%
SHARP CHULA VISTA MEDICAL CENTER	531	952	12,213	7.8%
SHARP MEMORIAL HOSPITAL	304	926	6,992	13.2%
ST. BERNARDINE MEDICAL CENTER	405	1,238	9,315	13.3%
ST. FRANCIS MEDICAL CENTER	62	168	1,426	11.8%
ST. HELENA HOSPITAL & HEALTH CENTER	419	725	9,637	7.5%
ST. JOHN'S HOSPITAL AND HEALTH CENTER	256	1,652	5,888	28.1%
ST. JOHN'S REGIONAL MEDICAL CENTER	90	53	2,070	2.6%
ST. JOSEPH HOSPITAL—ORANGE	293	840	6,739	12.5%
ST. JOSEPH'S MEDICAL CENTER OF STOCKTON	610	940	14,030	6.7%
ST. JUDE MEDICAL CENTER	205	455	4,715	9.7%
ST. MARY MEDICAL CENTER	87	62	2,001	3.1%
ST. VINCENT MEDICAL CENTER	74	77	1,702	4.5%
STANFORD UNIVERSITY HOSPITAL	269	758	6,187	12.3%
SUMMIT MEDICAL CENTER ★	325	698	7,475	9.3%
SUTTER MEMORIAL HOSPITAL ★	1,534	5,248	35,282	14.9%
THE HEART HOSPITAL, INC.	133	93	3,059	3.0%
TORRANCE MEMORIAL MEDICAL CENTER	401	1,524	9,223	16.5%
TRI–CITY MEDICAL CENTER	431	1,203	9,913	12.1%
UCLA MEDICAL CENTER	191	202	4,393	4.6%
UCSD/SAN DIEGO—UNIVERSITY MEDICAL CTR	191	158	4,393	3.6%
UCSF/MT ZION	44	70	1,012	6.9%
UNIVERSITY OF CALIFORNIA DAVIS MED CTR	74	199	1,702	11.7%
UNIVERSITY OF CALIFORNIA IRVINE MED CTR	94	430	2,162	19.9%
USC UNIVERSITY HOSPITAL	144	599	3,312	18.1%
WASHINGTON HOSPITAL—FREMONT	334	875	7,682	11.4%

★ Better than expected mortality rate, ▼ Worse than expected mortality rate.

Table G-4: Percent of Total Data Elements Missing, Sorted by % Missing for Each Hospital

Hospital	Number of Cases	Missing Data Elements	Total Data Elements	% Missing
DOCTORS MEDICAL CENTER—MODESTO	451	3,360	10,373	32.4%
ST. JOHN'S HOSPITAL AND HEALTH CENTER	256	1,652	5,888	28.1%
GLENDALE MEMORIAL HOSPITAL & HEALTH CTR	223	1,282	5,129	25.0%
UNIVERSITY OF CALIFORNIA IRVINE MED CTR	94	430	2,162	19.9%
DOWNEY COMMUNITY HOSPITAL ▼	239	1,086	5,497	19.8%
POMONA VALLEY HOSPITAL MEDICAL CENTER	527	2,374	12,121	19.6%
MILLS—PENINSULA MEDICAL CENTER	323	1,382	7,429	18.6%
KAISER FOUNDATION HOSP—GEARY (S.F.)	992	4,215	22,816	18.5%
USC UNIVERSITY HOSPITAL	144	599	3,312	18.1%
SAN ANTONIO COMMUNITY HOSPITAL	124	509	2,852	17.8%
MERCY GENERAL HOSPITAL	2,565	10,410	58,995	17.6%
NORTHRIDGE HOSPITAL MEDICAL CENTER	301	1,194	6,923	17.2%
LOS ANGELES CO USC MEDICAL CENTER	146	555	3,358	16.5%
TORRANCE MEMORIAL MEDICAL CENTER	401	1,524	9,223	16.5%
ALTA BATES MEDICAL CENTER	276	1,040	6,348	16.4%
MERCY SAN JUAN HOSPITAL ▼	408	1,535	9,384	16.4%
PRESBYTERIAN INTERCOMMUNITY HOSPITAL ▼	117	419	2,691	15.6%
COMMUNITY MEM HOSP—SAN BUENAVENTURA	202	715	4,646	15.4%
KAISER FOUNDATION HOSP—SUNSET	2,302	8,102	52,923	15.3%
MT DIABLO MEDICAL CENTER	561	1,942	12,903	15.1%
SUTTER MEMORIAL HOSPITAL ★	1,534	5,248	35,282	14.9%
DOMINICAN SANTA CRUZ HOSPITAL—SOQUEL	272	861	6,256	13.8%
MARIN GENERAL HOSPITAL	94	293	2,162	13.6%
LITTLE COMPANY OF MARY HOSPITAL	160	496	3,680	13.5%
ST. BERNARDINE MEDICAL CENTER	405	1,238	9,315	13.3%
SHARP MEMORIAL HOSPITAL	304	926	6,992	13.2%
REDDING MEDICAL CENTER	1,037	3,134	23,851	13.1%
KAWEAH DELTA DISTRICT HOSPITAL	562	1,628	12,926	12.6%
ST. JOSEPH HOSPITAL—ORANGE	293	840	6,739	12.5%
ALVARADO HOSPITAL MEDICAL CENTER	298	841	6,854	12.3%
STANFORD UNIVERSITY HOSPITAL	269	758	6,187	12.3%
TRI–CITY MEDICAL CENTER	431	1,203	9,913	12.1%
SANTA BARBARA COTTAGE HOSPITAL	267	738	6,141	12.0%
GLENDALE ADVENTIST MEDICAL CENTER	203	553	4,669	11.8%
ST. FRANCIS MEDICAL CENTER	62	168	1,426	11.8%
CITRUS VALLEY MEDICAL CENTER—IC CAMPUS	430	1,164	9,890	11.8%
RIVERSIDE COMMUNITY HOSPITAL	86	232	1,978	11.7%
UNIVERSITY OF CALIFORNIA DAVIS MED CTR	74	199	1,702	11.7%
METHODIST HOSPITAL OF SOUTHERN CAL	428	1,130	9,844	11.5%
LONG BEACH MEMORIAL MEDICAL CENTER	378	996	8,694	11.5%
WASHINGTON HOSPITAL—FREMONT	334	875	7,682	11.4%
GROSSMONT HOSPITAL (SHARP)	133	348	3,059	11.4%

★ Better than expected mortality rate, ▼ Worse than expected mortality rate.

Table G-4: Percent of Total Data Elements Missing Sorted by % Missing for Each Hospital (cont.)

Hospital	Number of Cases	Missing Data Elements	Total Data Elements	% Missing
DANIEL FREEMAN MEMORIAL HOSPITAL	173	423	3,979	10.6%
DOCTORS MEDICAL CENTER—SAN PABLO	169	410	3,887	10.5%
PALOMAR MEDICAL CENTER	349	795	8,027	9.9%
SEQUOIA HOSPITAL	483	1,086	11,109	9.8%
ST. JUDE MEDICAL CENTER	205	455	4,715	9.7%
CALIFORNIA PAC MED CTR—PACIFIC CAMPUS	176	388	4,048	9.6%
SUMMIT MEDICAL CENTER ★	325	698	7,475	9.3%
SADDLEBACK MEMORIAL MEDICAL CENTER	175	361	4,025	9.0%
ENCINO TARZANA REGIONAL MEDICAL CENTER	145	267	3,335	8.0%
SHARP CHULA VISTA MEDICAL CENTER	531	952	12,213	7.8%
ST. HELENA HOSPITAL & HEALTH CENTER	419	725	9,637	7.5%
CEDARS-SINAI MEDICAL CENTER	868	1,477	19,964	7.4%
MEDICAL CENTER AT THE UCSF	141	226	3,243	7.0%
UCSF/MT ZION	44	70	1,012	6.9%
ST. JOSEPH'S MEDICAL CENTER OF STOCKTON	610	940	14,030	6.7%
SANTA MONICA—UCLA MEDICAL CENTER	45	69	1,035	6.7%
PROVIDENCE SAINT JOSEPH MEDICAL CENTER	232	315	5,336	5.9%
GRANADA HILLS COMMUNITY HOSPITAL	142	167	3,266	5.1%
DESERT REGIONAL MEDICAL CENTER	122	141	2,806	5.0%
UCLA MEDICAL CENTER	191	202	4,393	4.6%
ST. VINCENT MEDICAL CENTER	74	77	1,702	4.5%
SCRIPPS MEMORIAL HOSPITAL—LA JOLLA	674	674	15,502	4.3%
EL CAMINO HOSPITAL	52	51	1,196	4.3%
MEMORIAL HOSPITAL MODESTO	550	505	12,650	4.0%
PROVIDENCE HOLY CROSS MEDICAL CENTER	114	101	2,622	3.9%
SETON MEDICAL CENTER	1,249	1,097	28,727	3.8%
JOHN MUIR MEDICAL CENTER ▼	128	111	2,944	3.8%
MERCY MEDICAL CENTER—REDDING	114	96	2,622	3.7%
UCSD/SAN DIEGO—UNIVERSITY MEDICAL CTR	191	158	4,393	3.6%
HOAG MEMORIAL HOSPITAL PRESBYTERIAN ★	496	379	11,408	3.3%
DAMERON HOSPITAL	107	78	2,461	3.2%
ST. MARY MEDICAL CENTER	87	62	2,001	3.1%
SALINAS VALLEY MEMORIAL HOSPITAL	135	96	3,105	3.1%
ANAHEIM MEMORIAL MEDICAL CENTER	130	91	2,990	3.0%
THE HEART HOSPITAL, INC.	133	93	3,059	3.0%
LANCASTER COMMUNITY HOSPITAL	23	16	529	3.0%
ST. JOHN'S REGIONAL MEDICAL CENTER	90	53	2,070	2.6%

★ Better than expected mortality rate, ▼ Worse than expected mortality rate.

Table G-5: Distribution of Comorbidities by Hospital, Sorted by 3+ Comorbidites

Hospital Name	0	1	2	3+
ENCINO TARZANA REGIONAL MEDICAL CENTER	13.1%	40.0%	27.6%	19.3%
DOCTORS MEDICAL CENTER—SAN PABLO	34.9%	32.5%	16.0%	16.6%
SHARP CHULA VISTA MEDICAL CENTER	26.7%	36.0%	21.5%	15.8%
SADDLEBACK MEMORIAL MEDICAL CENTER	20.0%	37.7%	28.0%	14.3%
SEQUOIA HOSPITAL	36.6%	32.9%	18.6%	11.8%
WASHINGTON HOSPITAL—FREMONT	36.8%	34.7%	17.1%	11.4%
UCSD/SAN DIEGO—UNIVERSITY MEDICAL CTR	40.8%	33.5%	15.7%	9.9%
DAMERON HOSPITAL	31.8%	46.7%	12.1%	9.3%
ST. MARY MEDICAL CENTER—LONG BEACH	33.3%	28.7%	28.7%	9.2%
CEDARS–SINAI MEDICAL CENTER	23.0%	50.1%	18.0%	8.9%
MERCY MEDICAL CENTER—REDDING	40.4%	36.8%	14.0%	8.8%
LANCASTER COMMUNITY HOSPITAL	60.9%	30.4%	0.0%	8.7%
UNIVERSITY OF CALIFORNIA IRVINE MED CTR	34.0%	38.3%	19.1%	8.5%
HOAG MEMORIAL PRESBYTERIAN ★	45.6%	32.9%	13.5%	8.1%
THE HEART HOSPITAL, INC.	45.1%	27.8%	19.5%	7.5%
ST. HELENA HOSPITAL & HEALTH CENTER	36.8%	35.6%	20.3%	7.4%
SUMMIT MEDICAL CENTER ★	39.4%	36.9%	16.3%	7.4%
RIVERSIDE COMMUNITY HOSPITAL	34.9%	39.5%	18.6%	7.0%
ST. VINCENT MEDICAL CENTER	31.1%	43.2%	18.9%	6.8%
ALVARADO HOSPITAL MEDICAL CENTER	35.6%	42.6%	15.1%	6.7%
SUTTER MEMORIAL HOSPITAL ★	41.7%	36.9%	14.8%	6.6%
SCRIPPS MEMORIAL HOSPITAL—LA JOLLA	42.7%	34.4%	16.3%	6.5%
SAN ANTONIO COMMUNITY HOSPITAL	33.1%	44.4%	16.1%	6.5%
ST. BERNARDINE MEDICAL CENTER	42.0%	37.5%	14.1%	6.4%
PALOMAR MEDICAL CENTER	42.4%	34.4%	17.2%	6.0%
GLENDALE MEMORIAL HOSPITAL & HEALTH CTR	31.4%	38.6%	24.2%	5.8%
LONG BEACH MEMORIAL MEDICAL CENTER	47.4%	35.2%	11.6%	5.8%
TORRANCE MEMORIAL MEDICAL CENTER	48.1%	33.7%	12.5%	5.7%
ST. JOSEPH HOSPITAL—ORANGE	51.2%	34.1%	9.2%	5.5%
SETON MEDICAL CENTER	44.0%	37.0%	13.6%	5.4%
KAWEAH DELTA DISTRICT HOSPITAL	40.4%	38.8%	15.7%	5.2%
ALTA BATES MEDICAL CENTER	49.6%	32.2%	13.0%	5.1%
CITRUS VALLEY MEDICAL CENTER–IC CAMPUS	44.4%	35.3%	15.3%	4.9%
ST. FRANCIS MEDICAL CENTER	35.5%	40.3%	19.4%	4.8%
MT DIABLO MEDICAL CENTER	42.2%	35.5%	17.5%	4.8%
ST. JOSEPH'S MEDICAL CENTER OF STOCKTON	38.7%	37.5%	19.0%	4.8%
SALINAS VALLEY MEMORIAL HOSPITAL	47.4%	39.3%	8.9%	4.4%
ST. JOHN'S REGIONAL MEDICAL CENTER	45.6%	33.3%	16.7%	4.4%
MARIN GENERAL HOSPITAL	63.8%	26.6%	5.3%	4.3%
DOWNEY COMMUNITY HOSPITAL ▼	38.1%	39.3%	18.4%	4.2%

★ Better than expected mortality rate, ▼ Worse than expected mortality rate.

Table G-5: Distribution of Comorbidities by Hospital, Sorted by 3+ Comobidites (cont.)

Hospital Name	0	1	2	3+
TRI–CITY MEDICAL CENTER	51.7%	32.5%	11.8%	3.9%
MERCY SAN JUAN HOSPITAL ▼	50.0%	34.8%	11.3%	3.9%
ANAHEIM MEMORIAL MEDICAL CENTER	43.1%	34.6%	18.5%	3.8%
SHARP GROSSMONT HOSPITAL	49.6%	25.6%	21.1%	3.8%
SHARP MEMORIAL HOSPITAL	50.0%	36.5%	9.9%	3.6%
DANIEL FREEMAN MEMORIAL HOSPITAL	42.8%	37.0%	16.8%	3.5%
PROVIDENCE SAINT JOSEPH MEDICAL CENTER	56.5%	29.7%	10.3%	3.4%
LOS ANGELES CO USC MEDICAL CENTER	43.2%	44.5%	8.9%	3.4%
ST. JUDE MEDICAL CENTER	51.7%	33.7%	11.2%	3.4%
USC UNIVERSITY HOSPITAL	48.6%	38.2%	10.4%	2.8%
NORTHRIDGE HOSPITAL MEDICAL CENTER	51.5%	35.5%	10.3%	2.7%
UCLA MEDICAL CENTER	48.2%	33.0%	16.2%	2.6%
STANFORD UNIVERSITY HOSPITAL	48.0%	37.5%	11.9%	2.6%
PRESBYTERIAN INTERCOMMUNITY HOSPITAL ▼	47.9%	38.5%	11.1%	2.6%
KAISER FOUNDATION HOSP—GEARY (S.F.)	52.5%	34.9%	10.1%	2.5%
COMMUNITY MEM HOSP—SAN BUENAVENTURA	61.4%	30.2%	5.9%	2.5%
POMONA VALLEY HOSPITAL MEDICAL CENTER	48.2%	39.5%	9.9%	2.5%
DESERT REGIONAL MEDICAL CENTER	45.1%	41.0%	11.5%	2.5%
METHODIST HOSPITAL OF SOUTHERN CAL	50.0%	37.9%	9.8%	2.3%
UCSF/MT ZION	50.0%	38.6%	9.1%	2.3%
MILLS–PENINSULA MEDICAL CENTER	64.1%	27.6%	6.2%	2.2%
GLENDALE ADVENTIST MEDICAL CENTER	42.4%	41.9%	13.8%	2.0%
EL CAMINO HOSPITAL	57.7%	30.8%	9.6%	1.9%
DOMINICAN SANTA CRUZ HOSPITAL—SOQUEL	50.0%	35.3%	12.9%	1.8%
MERCY GENERAL HOSPITAL	55.8%	33.3%	9.1%	1.8%
DOCTORS MEDICAL CENTER—MODESTO	53.0%	37.0%	8.2%	1.8%
KAISER FOUNDATION HOSP—SUNSET (L.A.)	47.5%	40.5%	10.3%	1.7%
REDDING MEDICAL CENTER	51.6%	35.9%	10.9%	1.6%
JOHN MUIR MEDICAL CENTER ▼	53.1%	35.9%	9.4%	1.6%
MEDICAL CENTER AT THE UCSF	46.1%	38.3%	14.2%	1.4%
GRANADA HILLS COMMUNITY HOSPITAL	62.7%	29.6%	6.3%	1.4%
UNIVERSITY OF CALIFORNIA DAVIS MED CTR	50.0%	39.2%	9.5%	1.4%
LITTLE COMPANY OF MARY HOSPITAL	55.6%	31.9%	11.3%	1.3%
SANTA BARBARA COTTAGE HOSPITAL	60.3%	30.3%	8.2%	1.1%
PROVIDENCE HOLY CROSS MEDICAL CENTER	59.6%	31.6%	7.9%	0.9%
ST. JOHN'S HOSPITAL AND HEALTH CENTER	60.2%	30.5%	8.6%	0.8%
CALIFORNIA PAC MED CTR—PACIFIC CAMPUS	68.2%	24.4%	6.8%	0.6%
MEMORIAL HOSPITAL MODESTO	56.5%	34.5%	8.4%	0.5%
SANTA MONICA—UCLA MEDICAL CENTER	57.8%	31.1%	11.1%	0.0%
OVERALL	45.8%	36.3%	13.2%	4.7%

★ Better than expected mortality rate, ▼ Worse than expected mortality rate.

Table G-6: Distribution of Acuity Variable by Hospital, Sorted by Emergent

Hospital Name	Elective	Urgent	Emergent	Salvage
LITTLE COMPANY OF MARY HOSPITAL	35.6%	43.1%	21.3%	0.0%
HOAG MEMORIAL PRESBYTERIAN ★	39.9%	40.1%	19.6%	0.4%
ENCINO TARZANA REGIONAL MEDICAL CENTER	73.8%	7.6%	18.6%	0.0%
TORRANCE MEMORIAL MEDICAL CENTER	28.7%	51.1%	18.5%	1.7%
ST. MARY MEDICAL CENTER—LONG BEACH	23.0%	58.6%	18.4%	0.0%
RIVERSIDE COMMUNITY HOSPITAL	37.2%	45.3%	16.3%	1.2%
PROVIDENCE HOLY CROSS MEDICAL CENTER	30.7%	53.5%	15.8%	0.0%
JOHN MUIR MEDICAL CENTER ▼	25.0%	59.4%	15.6%	0.0%
SAN ANTONIO COMMUNITY HOSPITAL	24.2%	59.7%	15.3%	0.8%
METHODIST HOSPITAL OF SOUTHERN CAL	40.4%	44.9%	14.5%	0.2%
MT DIABLO MEDICAL CENTER	31.9%	55.1%	12.7%	0.4%
SALINAS VALLEY MEMORIAL HOSPITAL	39.3%	46.7%	12.6%	1.5%
ST. JOSEPH HOSPITAL—ORANGE	57.3%	30.0%	12.3%	0.3%
UNIVERSITY OF CALIFORNIA DAVIS MED CTR	60.8%	27.0%	12.2%	0.0%
ALTA BATES MEDICAL CENTER	52.5%	34.8%	12.0%	0.7%
ST. BERNARDINE MEDICAL CENTER	34.3%	53.1%	11.6%	1.0%
WASHINGTON HOSPITAL—FREMONT	65.6%	21.3%	11.4%	1.8%
PROVIDENCE SAINT JOSEPH MEDICAL CENTER	51.7%	37.1%	11.2%	0.0%
SANTA MONICA—UCLA MEDICAL CENTER	22.2%	66.7%	11.1%	0.0%
MARIN GENERAL HOSPITAL	55.3%	34.0%	10.6%	0.0%
SHARP CHULA VISTA MEDICAL CENTER	54.8%	35.0%	10.2%	0.0%
DOMINICAN SANTA CRUZ HOSPITAL—SOQUEL	47.1%	41.5%	9.9%	1.5%
SANTA BARBARA COTTAGE HOSPITAL	57.3%	33.0%	9.7%	0.0%
UCLA MEDICAL CENTER	40.3%	49.2%	9.4%	1.0%
ST. HELENA HOSPITAL & HEALTH CENTER	33.9%	56.8%	9.3%	0.0%
NORTHRIDGE HOSPITAL MEDICAL CENTER	51.8%	38.2%	9.0%	1.0%
POMONA VALLEY HOSPITAL MEDICAL CENTER	64.5%	25.8%	8.9%	0.8%
ST. JUDE MEDICAL CENTER	79.5%	10.7%	8.8%	1.0%
MERCY MEDICAL CENTER—REDDING	18.4%	70.2%	8.8%	2.6%
LANCASTER COMMUNITY HOSPITAL	60.9%	30.4%	8.7%	0.0%
LOS ANGELES CO USC MEDICAL CENTER	45.2%	44.5%	8.2%	2.1%
ST. JOSEPH'S MEDICAL CENTER OF STOCKTON	37.9%	53.8%	8.2%	0.2%
DANIEL FREEMAN MEMORIAL HOSPITAL	75.1%	16.8%	8.1%	0.0%
LONG BEACH MEMORIAL MEDICAL CENTER	41.0%	51.1%	7.9%	0.0%
ALVARADO HOSPITAL MEDICAL CENTER	33.2%	58.7%	7.7%	0.3%
CALIFORNIA PAC MED CTR—PACIFIC CAMPUS	71.6%	21.0%	7.4%	0.0%
UCSD/SAN DIEGO—UNIVERSITY MEDICAL CTR	58.1%	34.6%	7.3%	0.0%
GLENDALE MEMORIAL HOSPITAL & HEALTH CTR	16.6%	75.8%	7.2%	0.4%
ST. VINCENT MEDICAL CENTER	63.5%	29.7%	6.8%	0.0%
ST. JOHN'S HOSPITAL AND HEALTH CENTER	41.4%	51.2%	6.6%	0.8%

★ Better than expected mortality rate, ▼ Worse than expected mortality rate.

Table G-6: Distribution of Acuity Variable by Hospital, Sorted by Emergent (cont.)

Hospital Name	Elective	Urgent	Emergent	Salvage
CITRUS VALLEY MEDICAL CENTER—IC CAMPUS	70.9%	22.6%	6.5%	0.0%
TRI–CITY MEDICAL CENTER	44.1%	48.7%	6.5%	0.7%
ST. FRANCIS MEDICAL CENTER	33.9%	58.1%	6.5%	1.6%
SUMMIT MEDICAL CENTER ★	61.5%	30.5%	5.8%	2.2%
SADDLEBACK MEMORIAL MEDICAL CENTER	50.9%	43.4%	5.7%	0.0%
ST. JOHN'S REGIONAL MEDICAL CENTER	61.1%	32.2%	5.6%	1.1%
DOWNEY COMMUNITY HOSPITAL ▼	50.6%	43.5%	5.4%	0.4%
GLENDALE ADVENTIST MEDICAL CENTER	60.1%	34.0%	5.4%	0.5%
ANAHEIM MEMORIAL MEDICAL CENTER	66.2%	27.7%	5.4%	0.8%
SEQUOIA HOSPITAL	69.4%	25.1%	5.4%	0.2%
SUTTER MEMORIAL HOSPITAL ★	69.2%	25.0%	5.3%	0.4%
MILLS–PENINSULA MEDICAL CENTER	63.8%	29.7%	5.3%	1.2%
REDDING MEDICAL CENTER	54.1%	40.1%	5.2%	0.6%
MERCY SAN JUAN HOSPITAL ▼	18.6%	76.2%	5.1%	0.0%
DESERT REGIONAL MEDICAL CENTER	72.1%	23.0%	4.9%	0.0%
CEDARS–SINAI MEDICAL CENTER	63.8%	31.1%	4.7%	0.3%
DAMERON HOSPITAL	47.7%	46.7%	4.7%	0.9%
UCSF/MT ZION	45.5%	50.0%	4.5%	0.0%
SHARP GROSSMONT HOSPITAL	83.5%	12.0%	4.5%	0.0%
SCRIPPS MEMORIAL HOSPITAL—LA JOLLA	54.2%	40.2%	4.2%	1.5%
DOCTORS MEDICAL CENTER—SAN PABLO	39.1%	54.4%	4.1%	2.4%
SHARP MEMORIAL HOSPITAL	82.6%	13.5%	3.9%	0.0%
EL CAMINO HOSPITAL	67.3%	26.9%	3.8%	1.9%
PALOMAR MEDICAL CENTER	27.5%	68.8%	3.4%	0.3%
PRESBYTERIAN INTERCOMMUNITY HOSPITAL ▼	71.8%	20.5%	3.4%	4.3%
KAWEAH DELTA DISTRICT HOSPITAL	44.3%	51.8%	3.4%	0.5%
SETON MEDICAL CENTER	64.0%	32.7%	3.4%	0.0%
MEMORIAL HOSPITAL MODESTO	62.2%	34.5%	3.3%	0.0%
KAISER FOUNDATION HOSP—GEARY (S.F.)	85.4%	11.0%	3.1%	0.5%
USC UNIVERSITY HOSPITAL	79.9%	17.4%	2.8%	0.0%
MERCY GENERAL HOSPITAL	31.9%	65.3%	2.8%	0.0%
UNIVERSITY OF CALIFORNIA IRVINE MED CTR	48.9%	47.9%	2.1%	1.1%
GRANADA HILLS COMMUNITY HOSPITAL	67.6%	30.3%	2.1%	0.0%
DOCTORS MEDICAL CENTER—MODESTO	98.0%	0.0%	2.0%	0.0%
STANFORD UNIVERSITY HOSPITAL	82.9%	15.2%	1.9%	0.0%
THE HEART HOSPITAL, INC.	71.4%	27.1%	1.5%	0.0%
COMMUNITY MEM HOSP—SAN BUENAVENTURA	92.6%	5.9%	1.5%	0.0%
KAISER FOUNDATION HOSP—SUNSET (L.A.)	26.9%	71.4%	1.5%	0.3%
MEDICAL CENTER AT THE UCSF	43.3%	54.6%	1.4%	0.7%
OVERALL	51.6%	41.5%	6.4%	0.5%

★ Better than expected mortality rate, ▼ Worse than expected mortality rate.

Table G-7: Distribution of Ejection Fraction Variable by Hospital, Sorted by <30

Hospital Name	<30	>=30 & <40	>= 40 & <50	>=50
ST. FRANCIS MEDICAL CENTER	21.0%	17.7%	19.4%	41.9%
ST. MARY MEDICAL CENTER—LONG BEACH	13.8%	16.1%	18.4%	51.7%
GLENDALE ADVENTIST MEDICAL CENTER	12.8%	11.8%	26.6%	48.8%
RIVERSIDE COMMUNITY HOSPITAL	11.6%	10.5%	11.6%	66.3%
UCSF/MT ZION	11.4%	11.4%	25.0%	52.3%
SEQUOIA HOSPITAL	11.2%	12.4%	13.9%	62.5%
UNIVERSITY OF CALIFORNIA IRVINE MED CTR	10.6%	13.8%	12.8%	62.8%
UCLA MEDICAL CENTER	10.5%	11.5%	14.1%	63.9%
POMONA VALLEY HOSPITAL MEDICAL CENTER	9.5%	17.8%	32.6%	40.0%
ENCINO TARZANA REGIONAL MEDICAL CENTER	9.0%	66.2%	0.0%	24.8%
UCSD/SAN DIEGO—UNIVERSITY MEDICAL CTR	8.9%	16.8%	21.5%	52.9%
ST. BERNARDINE MEDICAL CENTER	8.9%	10.1%	25.2%	55.8%
MARIN GENERAL HOSPITAL	8.5%	8.5%	20.2%	62.8%
MEDICAL CENTER AT THE UCSF	8.5%	14.2%	14.9%	62.4%
ST. JOSEPH'S MEDICAL CENTER OF STOCKTON	8.4%	8.0%	13.0%	70.7%
USC UNIVERSITY HOSPITAL	8.3%	6.9%	9.0%	75.7%
SALINAS VALLEY MEMORIAL HOSPITAL	8.1%	11.1%	14.8%	65.9%
ST. VINCENT MEDICAL CENTER	8.1%	10.8%	17.6%	63.5%
GLENDALE MEMORIAL HOSPITAL & HEALTH CTR	8.1%	17.5%	19.3%	55.2%
ST. JOHN'S REGIONAL MEDICAL CENTER	7.8%	7.8%	25.6%	58.9%
LOS ANGELES CO USC MEDICAL CENTER	7.5%	13.7%	17.8%	61.0%
DAMERON HOSPITAL	7.5%	9.3%	14.0%	69.2%
SAN ANTONIO COMMUNITY HOSPITAL	7.3%	19.4%	28.2%	45.2%
SUMMIT MEDICAL CENTER ★	7.1%	11.4%	14.2%	67.4%
GRANADA HILLS COMMUNITY HOSPITAL	7.0%	18.3%	32.4%	42.3%
NORTHRIDGE HOSPITAL MEDICAL CENTER	7.0%	9.3%	16.3%	67.4%
SETON MEDICAL CENTER	6.7%	14.5%	25.9%	52.8%
SANTA MONICA—UCLA MEDICAL CENTER	6.7%	26.7%	26.7%	40.0%
DOCTORS MEDICAL CENTER—SAN PABLO	6.5%	20.1%	21.9%	51.5%
MILLS–PENINSULA MEDICAL CENTER	6.5%	9.6%	17.0%	66.9%
PROVIDENCE SAINT JOSEPH MEDICAL CENTER	6.5%	8.6%	19.0%	65.9%
CALIFORNIA PAC MED CTR—PACIFIC CAMPUS	6.3%	11.4%	17.0%	65.3%
JOHN MUIR MEDICAL CENTER ▼	6.3%	9.4%	10.2%	74.2%
PROVIDENCE HOLY CROSS MEDICAL CENTER	6.1%	19.3%	12.3%	62.3%
LONG BEACH MEMORIAL MEDICAL CENTER	5.8%	8.7%	14.6%	70.9%
SHARP MEMORIAL HOSPITAL	5.6%	10.5%	8.2%	75.7%
STANFORD UNIVERSITY HOSPITAL	5.6%	10.4%	10.0%	74.0%
ANAHEIM MEMORIAL MEDICAL CENTER	5.4%	17.7%	16.9%	60.0%
SUTTER MEMORIAL HOSPITAL ★	5.3%	8.5%	13.4%	72.8%

★ Better than expected mortality rate, ▼ Worse than expected mortality rate.

Table G7: Distribution of Ejection Fraction Variable by Hospital, Sorted by <30 (cont.)

Hospital Name	<30	>=30 & <40	>= 40 & <50	>=50
HOAG MEMORIAL PRESBYTERIAN ★	5.0%	9.5%	16.9%	68.5%
MEMORIAL HOSPITAL MODESTO	4.9%	9.3%	16.0%	69.8%
SCRIPPS MEMORIAL HOSPITAL—LA JOLLA	4.7%	9.2%	12.6%	73.4%
ALVARADO HOSPITAL MEDICAL CENTER	4.7%	11.7%	18.5%	65.1%
DANIEL FREEMAN MEMORIAL HOSPITAL	4.6%	6.4%	24.9%	64.2%
CEDARS–SINAI MEDICAL CENTER	4.6%	6.7%	18.8%	69.9%
SHARP GROSSMONT HOSPITAL	4.5%	14.3%	13.5%	67.7%
WASHINGTON HOSPITAL—FREMONT	4.5%	8.4%	26.0%	61.1%
MT DIABLO MEDICAL CENTER	4.5%	8.7%	10.7%	76.1%
LITTLE COMPANY OF MARY HOSPITAL	4.4%	5.0%	9.4%	81.3%
SHARP CHULA VISTA MEDICAL CENTER	4.3%	14.3%	10.7%	70.6%
KAWEAH DELTA DISTRICT HOSPITAL	4.3%	14.9%	35.9%	44.8%
DESERT REGIONAL MEDICAL CENTER	4.1%	9.8%	13.9%	72.1%
UNIVERSITY OF CALIFORNIA DAVIS MED CTR	4.1%	9.5%	13.5%	73.0%
DOWNEY COMMUNITY HOSPITAL ▼	3.8%	8.4%	18.4%	69.5%
THE HEART HOSPITAL, INC.	3.8%	9.8%	22.6%	63.9%
KAISER FOUNDATION HOSP—GEARY (S.F.)	3.6%	8.6%	12.1%	75.7%
ALTA BATES MEDICAL CENTER	3.6%	10.1%	12.7%	73.6%
ST. JOHN'S HOSPITAL AND HEALTH CENTER	3.1%	9.4%	20.7%	66.8%
METHODIST HOSPITAL OF SOUTHERN CAL	3.0%	4.4%	9.3%	83.2%
KAISER FOUNDATION HOSP—SUNSET (L.A.)	3.0%	6.0%	9.5%	81.5%
DOMINICAN SANTA CRUZ HOSPITAL—SOQUEL	2.9%	8.8%	13.6%	74.6%
ST. JUDE MEDICAL CENTER	2.9%	6.3%	11.2%	79.5%
PALOMAR MEDICAL CENTER	2.9%	6.6%	14.3%	76.2%
TRI–CITY MEDICAL CENTER	2.8%	6.7%	16.7%	73.8%
TORRANCE MEMORIAL MEDICAL CENTER	2.7%	5.2%	11.5%	80.5%
MERCY SAN JUAN HOSPITAL ▼	2.7%	5.6%	14.5%	77.2%
MERCY MEDICAL CENTER—REDDING	2.6%	11.4%	23.7%	62.3%
ST. HELENA HOSPITAL & HEALTH CENTER	2.6%	2.9%	11.2%	83.3%
SANTA BARBARA COTTAGE HOSPITAL	2.6%	8.2%	10.9%	78.3%
CITRUS VALLEY MEDICAL CENTER—IC CAMPUS	2.6%	9.5%	15.6%	72.3%
MERCY GENERAL HOSPITAL	2.5%	7.7%	17.1%	72.7%
COMMUNITY MEM HOSP—SAN BUENAVENTURA	2.5%	5.0%	14.9%	77.7%
ST. JOSEPH HOSPITAL—ORANGE	2.0%	6.5%	13.3%	78.2%
REDDING MEDICAL CENTER	1.8%	4.8%	14.9%	78.5%
SADDLEBACK MEMORIAL MEDICAL CENTER	1.1%	10.3%	14.9%	73.7%
PRESBYTERIAN INTERCOMMUNITY HOSPITAL ▼	0.9%	12.0%	15.4%	71.8%
EL CAMINO HOSPITAL	0.0%	15.4%	21.2%	63.5%
LANCASTER COMMUNITY HOSPITAL	0.0%	8.7%	4.3%	87.0%
OVERALL	4.9%	9.7%	16.1%	69.4%

★ Better than expected mortality rate, ▼ Worse than expected mortality rate.

Table G–8: HOSPITAL CODING PRACTICES OF DATA ELEMENTS IN RISK–ADJUSTMENT MODEL

	Percent of Hospital CABG Cases Coded as:								
	Status	Gender	Race	HTN	Dialysis	Diabetes	PVD	CVD	Ventr Arrth
	Dead	Female	Non–White	Yes	Yes	Yes	Yes	Yes	Yes
AVERAGE	2.5%	27.5%	23.0%	67.8%	1.7%	33.3%	13.6%	10.6%	5.2%
ALTA BATES MEDICAL CENTER	4.0%	24.3%	26.8%	31.2%	15.9%	17.4%	20.7%	5.4%	1.4%
ALVARADO HOSPITAL MEDICAL CENTER	5.4%	27.2%	24.5%	73.2%	2.0%	35.6%	17.1%	11.4%	7.4%
ANAHEIM MEMORIAL MEDICAL CENTER	3.1%	28.5%	28.5%	80.0%	2.3%	37.7%	14.6%	16.2%	1.5%
CALIFORNIA PAC MED CTR–PACIFIC CAMPUS	3.4%	25.6%	37.5%	63.1%	3.4%	5.7%	9.7%	6.8%	2.8%
CEDARS–SINAI MEDICAL CENTER	2.2%	24.2%	13.8%	62.3%	2.6%	66.8%	19.1%	11.9%	3.6%
CITRUS VALLEY MEDICAL CENTER—IC CAMPUS	3.7%	33.3%	31.2%	68.8%	3.0%	35.8%	15.1%	8.8%	5.3%
COMMUNITY MEMORIAL HOSP —SAN BUENAVENTURA	2.0%	24.8%	17.3%	64.4%	1.0%	27.2%	8.4%	3.5%	3.0%
DAMERON HOSPITAL	2.8%	36.4%	39.3%	69.2%	2.8%	46.7%	15.0%	12.1%	3.7%
DANIEL FREEMAN MEMORIAL HOSPITAL	1.2%	31.2%	49.1%	85.0%	1.7%	35.3%	12.7%	12.7%	8.1%
DESERT REGIONAL MEDICAL CENTER	4.1%	22.1%	9.0%	79.5%	2.5%	30.3%	9.0%	10.7%	9.0%
DOCTORS MEDICAL CENTER—MODESTO	2.4%	29.7%	7.1%	63.6%	0.4%	28.2%	8.6%	5.1%	3.5%
DOCTORS MEDICAL CENTER—SAN PABLO	1.8%	40.2%	39.1%	73.4%	1.8%	44.4%	27.8%	16.6%	4.7%
DOMINICAN SANTA CRUZ HOSPITAL—SOQUEL	3.7%	25.0%	11.4%	65.1%	1.1%	25.7%	19.5%	5.9%	4.4%
DOWNEY COMMUNITY HOSPITAL ▼	5.4%	35.1%	35.1%	72.0%	0.4%	37.7%	17.2%	10.0%	0.4%
EL CAMINO HOSPITAL	1.9%	23.1%	21.2%	86.5%	5.8%	19.2%	17.3%	1.9%	9.6%
ENCINO TARZANA REGIONAL MEDICAL CENTER	1.4%	28.3%	1.4%	69.7%	4.1%	32.4%	15.2%	17.9%	71.7%
GLENDALE ADVENTIST MEDICAL CENTER	3.4%	32.0%	21.2%	75.4%	2.5%	36.0%	9.4%	3.4%	12.8%
GLENDALE MEMORIAL HOSPITAL & HEALTH CTR	3.6%	38.6%	28.3%	80.3%	2.7%	46.2%	26.5%	10.3%	4.0%
GRANADA HILLS COMMUNITY HOSPITAL	2.8%	29.6%	35.2%	64.8%	0.7%	26.1%	5.6%	11.3%	0.7%
HOAG MEMORIAL PRESBYTERIAN ★	1.8%	17.9%	11.3%	62.7%	1.8%	28.0%	14.7%	17.1%	11.5%

upper tercile. middle tercile. lower tercile.

★Better than expected mortality rate, ▼Worse than expected mortality rate.

Table G–8: HOSPITAL CODING PRACTICES OF DATA ELEMENTS IN RISK–ADJUSTMENT MODEL (cont.)

	Percent of Hospital CABG Cases Coded as:								
	Status	Gender	Race	HTN	Dialysis	Diabetes	PVD	CVD	Ventr Arrth
	Dead	Female	Non–White	Yes	Yes	Yes	Yes	Yes	Yes
AVERAGE	2.5%	27.5%	23.0%	67.8%	1.7%	33.3%	13.6%	10.6%	5.2%
JOHN MUIR MEDICAL CENTER ▼	7.0%	28.9%	0.8%	62.5%	1.6%	25.8%	10.2%	10.9%	6.3%
KAISER FOUNDATION HOSPITAL—GEARY (S.F.)	2.1%	22.8%	24.9%	64.6%	1.9%	30.6%	11.6%	9.0%	3.8%
KAISER FOUNDATION HOSPITAL—SUNSET (L.A.)	1.3%	22.5%	31.7%	71.0%	0.9%	38.5%	8.8%	4.0%	4.1%
KAWEAH DELTA DISTRICT HOSPITAL	1.6%	31.5%	26.2%	69.8%	2.3%	35.6%	12.8%	11.4%	4.3%
LANCASTER COMMUNITY HOSPITAL	0.0%	47.8%	17.4%	47.8%	0.0%	17.4%	8.7%	17.4%	4.3%
LITTLE COMPANY OF MARY HOSPITAL	2.5%	26.9%	25.6%	65.6%	3.1%	28.8%	7.5%	3.8%	6.9%
LONG BEACH MEMORIAL MEDICAL CENTER	1.9%	29.6%	25.1%	77.2%	1.3%	28.8%	15.1%	11.4%	7.1%
LOS ANGELES CO USC MEDICAL CENTER	2.7%	28.8%	69.2%	65.1%	0.0%	48.6%	10.3%	4.1%	1.4%
MARIN GENERAL HOSPITAL	2.1%	17.0%	7.4%	54.3%	1.1%	17.0%	8.5%	7.4%	5.3%
MEDICAL CENTER AT THE UCSF	5.0%	30.5%	51.8%	64.5%	6.4%	34.0%	8.5%	7.1%	5.7%
MEMORIAL HOSPITAL MODESTO	2.9%	26.0%	13.8%	63.5%	3.3%	31.3%	7.5%	7.1%	3.8%
MERCY GENERAL HOSPITAL	1.2%	25.5%	13.8%	60.2%	0.6%	27.8%	9.2%	7.5%	2.2%
MERCY MEDICAL CENTER–REDDING	2.6%	26.3%	3.5%	66.7%	0.9%	30.7%	16.7%	12.3%	1.8%
MERCY SAN JUAN HOSPITAL ▼	4.2%	30.6%	8.1%	67.9%	1.0%	29.7%	10.0%	11.8%	5.9%
METHODIST HOSPITAL OF SOUTHERN CAL	4.0%	28.7%	19.2%	65.9%	0.5%	34.6%	15.4%	10.5%	1.2%
MILLS–PENINSULA MEDICAL CENTER	4.3%	22.6%	24.5%	52.3%	0.6%	23.8%	9.9%	7.7%	2.2%
MT DIABLO MEDICAL CENTER	3.6%	31.4%	23.2%	67.2%	2.0%	34.0%	16.4%	20.3%	5.3%
NORTHRIDGE HOSPITAL MEDICAL CENTER	3.0%	27.9%	9.6%	75.4%	1.7%	33.9%	11.6%	9.3%	3.0%
PALOMAR MEDICAL CENTER	3.7%	29.5%	9.2%	67.6%	1.1%	26.1%	20.9%	16.6%	9.2%
POMONA VALLEY HOSPITAL MEDICAL CENTER	3.4%	30.4%	28.8%	69.1%	0.8%	33.2%	8.0%	4.4%	3.2%

upper tercile. middle tercile. lower tercile.

★Better than expected mortality rate, ▼Worse than expected mortality rate.

Table G–8: HOSPITAL CODING PRACTICES OF DATA ELEMENTS IN RISK–ADJUSTMENT MODEL (cont.)

	Percent of Hospital CABG Cases Coded as:								
	Status	Gender	Race	HTN	Dialysis	Diabetes	PVD	CVD	Ventr Arrth
	Dead	Female	Non–White	Yes	Yes	Yes	Yes	Yes	Yes
AVERAGE	2.5%	27.5%	23.0%	67.8%	1.7%	33.3%	13.6%	10.6%	5.2%
PRESBYTERIAN INTERCOMMUNITY HOSPITAL ▼	7.7%	34.2%	33.3%	67.5%	2.6%	31.6%	5.1%	7.7%	6.8%
PROVIDENCE HOLY CROSS MEDICAL CENTER	2.6%	21.9%	25.4%	86.0%	0.9%	31.6%	7.9%	1.8%	1.8%
PROVIDENCE SAINT JOSEPH MEDICAL CENTER	1.3%	17.7%	10.8%	67.2%	1.7%	27.6%	10.8%	6.0%	7.3%
REDDING MEDICAL CENTER	1.4%	30.6%	3.5%	58.2%	0.6%	20.3%	10.1%	10.2%	0.3%
RIVERSIDE COMMUNITY HOSPITAL	8.1%	34.9%	30.2%	70.9%	1.2%	39.5%	17.4%	10.5%	5.8%
SADDLEBACK MEMORIAL MEDICAL CENTER	5.1%	23.4%	84.0%	62.9%	0.6%	77.7%	22.3%	8.6%	5.1%
SALINAS VALLEY MEMORIAL HOSPITAL	1.5%	30.4%	34.1%	64.4%	5.2%	39.3%	9.6%	8.9%	7.4%
SAN ANTONIO COMMUNITY HOSPITAL	2.4%	17.7%	20.2%	79.0%	0.0%	29.0%	12.9%	8.1%	3.7%
SANTA BARBARA COTTAGE HOSPITAL	3.4%	28.1%	15.4%	56.6%	2.2%	20.2%	8.2%	12.7%	2.6%
SANTA MONICA—UCLA MEDICAL CENTER	.4%	35.6%	13.3%	55.6%	0.0%	24.4%	11.1%	15.6%	0.0%
SCRIPPS MEMORIAL HOSPITAL—LA JOLLA	2.2%	25.5%	19.1%	69.0%	1.5%	30.7%	16.2%	15.9%	7.0%
SEQUOIA HOSPITAL	3.7%	25.7%	18.0%	73.7%	1.2%	35.2%	23.8%	20.7%	7.9%
SETON MEDICAL CENTER	1.4%	27.9%	41.2%	75.1%	1.2%	36.1%	11.1%	12.2%	0.7%
SHARP CHULA VISTA MEDICAL CENTER	4.3%	39.9%	66.9%	74.4%	5.3%	43.1%	23.0%	12.8%	20.5%
SHARP GROSSMONT HOSPITAL	0.8%	38.3%	14.3%	88.7%	2.3%	31.6%	15.8%	12.0%	6.8%
SHARP MEMORIAL HOSPITAL	1.3%	27.0%	19.1%	71.7%	0.3%	30.9%	15.1%	10.2%	2.6%
ST. BERNARDINE MEDICAL CENTER	2.7%	32.8%	7.9%	59.3%	1.0%	28.1%	11.9%	10.1%	5.9%
ST. FRANCIS MEDICAL CENTER	.8%	48.4%	82.3%	85.5%	11.3%	43.5%	9.7%	8.1%	8.1%
ST. HELENA HOSPITAL & HEALTH CENTER	1.9%	34.6%	14.3%	74.5%	0.7%	31.3%	20.8%	17.4%	9.8%
ST. JOHN'S HOSPITAL AND HEALTH CENTER	2.0%	17.6%	9.0%	49.6%	0.0%	25.4%	10.2%	3.1%	4.3%

upper tercile. middle tercile. lower tercile.

★Better than expected mortality rate, ▼Worse than expected mortality rate.

Table G–8: HOSPITAL CODING PRACTICES OF DATA ELEMENTS IN RISK–ADJUSTMENT MODEL (cont.)

	Percent of Hospital CABG Cases Coded as:								
	Status	Gender	Race	HTN	Dialysis	Diabetes	PVD	CVD	Ventr Arrth
	Dead	Female	Non–White	Yes	Yes	Yes	Yes	Yes	Yes
AVERAGE	2.5%	27.5%	23.0%	67.8%	1.7%	33.3%	13.6%	10.6%	5.2%
ST. JOHN'S REGIONAL MEDICAL CENTER	2.2%	21.1%	26.7%	64.4%	2.2%	28.9%	24.4%	13.3%	5.6%
ST. JOSEPH HOSPITAL—ORANGE	2.7%	21.5%	14.0%	68.9%	2.4%	32.8%	13.3%	3.1%	5.8%
ST. JOSEPH'S MEDICAL CENTER OF STOCKTON	3.3%	31.0%	22.3%	70.3%	1.3%	37.7	14.8%	14.4%	3.3%
ST. JUDE MEDICAL CENTER	3.9%	25.4%	13.7%	63.9%	0.5%	28.8%	8.3%	3.9%	3.2%
ST. MARY MEDICAL CENTER—LONG BEACH	8.0%	35.6%	33.3%	77.0%	5.7%	46.0%	23.0%	14.9%	4.6%
ST. VINCENT MEDICAL CENTER	2.7%	31.1%	39.2%	82.4%	4.1%	56.8%	13.5%	4.9%	0.0%
STANFORD UNIVERSITY HOSPITAL	3.7%	19.3%	29.4%	66.2%	1.1%	32.0%	11.2%	16.4%	2.6%
SUMMIT MEDICAL CENTER ★	1.5%	29.2%	40.6%	72.9%	2.2%	37.5%	20.3%	11.4%	3.4%
SUTTER MEMORIAL HOSPITAL ★	1.6%	28.2%	13.2%	68.1%	1.4%	32.1%	17.8%	17.7%	2.2%
THE HEART HOSPITAL, INC.	0.8%	24.1%	10.5%	75.9%	1.5%	19.5%	21.1%	21.8%	6.0%
ORRANCE MEMORIAL MEDICAL CENTER	5.0%	28.7%	24.2%	70.6%	2.7%	31.2%	13.5%	13.5%	5.7%
TRI–CITY MEDICAL CENTER	1.6%	28.1%	9.7%	64.0%	1.2%	28.5%	11.6%	13.5%	4.6%
UCLA MEDICAL CENTER	3.7%	19.9%	22.0%	75.4%	3.1%	35.6%	13.1%	11.0%	4.7%
UCSD/SAN DIEGO—UNIVERSITY MEDICAL CTR	4.7%	29.3%	41.4%	75.4%	3.7%	44.0%	21.5%	11.0%	6.3%
UCSF/MT ZION	4.5%	31.8%	29.5%	79.5%	0.0%	34.1%	11.4%	9.1%	9.1%
UNIVERSITY OF CALIFORNIA DAVIS MED CTR	2.7%	25.7%	97.3%	77.0%	0.0%	33.8%	13.5%	4.1%	0.0%
UNIVERSITY OF CALIFORNIA IRVINE MED CTR	0.0%	21.3%	38.3%	74.5%	4.3%	50.0%	18.1%	13.8%	2.1%
USC UNIVERSITY HOSPITAL	2.8%	25.0%	38.9%	78.5%	1.4%	38.2%	11.1%	6.9%	4.2%
WASHINGTON HOSPITAL—FREMONT	4.2%	39.2%	45.5%	78.7%	2.7%	38.3%	20.1%	19.5%	6.3%

upper tercile. middle tercile. lower tercile.

★Better than expected mortality rate, ▼Worse than expected mortality rate.

Table G–8: HOSPITAL CODING PRACTICES OF DATA ELEMENTS IN RISK–ADJUSTMENT MODEL (cont.)

	Percent of Hospital CABG Cases Coded as:								
	COPD	#Co Morbids	# Prior Ops	MI	PTCA	Angina	NYHA	NYHA	CCS
	Yes	3+	3+	0–7 days	Yes	None	III	III or IV	III
AVERAGE	13.3%	4.7%	0.6%	19.9%	3.8%	10.0%	17.4%	29.1%	39.8%
ALTA BATES MEDICAL CENTER	13.4%	5.1%	0.0%	14.9%	3.6%	11.6%	3.3%	62.3%	51.4%
ALVARADO HOSPITAL MEDICAL CENTER	21.1%	6.7%	2.3%	14.1%	0.0%	10.4%	10.4%	15.4%	43.6%
ANAHEIM MEMORIAL MEDICAL CENTER	10.8%	3.8%	0.0%	14.6%	4.6%	0.0%	6.9%	10.0%	20.0%
CALIFORNIA PAC MED CTR—PACIFIC CAMPUS	11.4%	0.6%	0.0%	22.2%	24.4%	6.3%	9.7%	14.2%	30.1%
CEDARS–SINAI MEDICAL CENTER	10.5%	8.9%	0.9%	0.0%	3.2%	8.8%	5.6%	10.6	42.4%
CITRUS VALLEY MEDICAL CENTER—IC CAMPUS	13.3%	4.9%	0.0%	27.2%	4.9%	22.3%	68.4%	83.5%	59.5%
COMMUNITY MEM HOSP —SAN BUENAVENTURA	6.4%	2.5%	1.0%	14.9%	3.5%	8.9%	96.5%	99.0%	96.5%
DAMERON HOSPITAL	2.4%	9.3%	3.7%	8.4%	0.9%	0.0%	69.2%	82.2%	58.9%
DANIEL FREEMAN MEMORIAL HOSPITAL	10.4%	3.5%	5.2%	16.2%	0.6%	5.8%	0.0%	0.0%	8.7%
DESERT REGIONAL MEDICAL CENTER	9.8%	2.5%	0.0%	25.4%	4.1%	0.0%	4.1%	42.6%	14.8%
DOCTORS MEDICAL CENTER—MODESTO	13.1%	1.8%	0.2%	22.8%	3.5%	5.1%	55.7%	73.2%	77.8%
DOCTORS MEDICAL CENTER—SAN PABLO	24.3%	16.6%	0.0%	28.4%	5.9%	9.5%	10.7%	20.1%	8.3%
DOMINICAN SANTA CRUZ HOSPITAL – SOQUEL	9.9%	1.8%	0.0%	21.7%	5.1%	9.9%	10.3%	23.5%	22.1%
DOWNEY COMMUNITY HOSPITAL ★	23.0%	4.2%	0.8%	22.2%	5.4%	5.4%	21.8%	27.2%	33.5%
EL CAMINO HOSPITAL	1.9%	1.9%	1.9%	5.8%	1.9%	0.0%	51.9%	59.6%	50.0%
ENCINO TARZANA REGIONAL MEDICAL CENTER	15.2%	19.3%	0.0%	9.7%	4.1%	11.7%	19.3%	57.9	36.6%
GLENDALE ADVENTIST MEDICAL CENTER	11.8%	2.0%	0.0%	15.8%	10.8%	5.4%	27.1%	40.9%	31.0%
GLENDALE MEMORIAL HOSPITAL & HEALTH CTR	15.7%	5.8%	0.0%	22.9%	2.7%	12.6%	21.1%	96.0%	20.2%
GRANADA HILLS COMMUNITY HOSPITAL	2.8%	1.4%	0.0%	11.3%	0.0%	0.0%	6.3%	8.5%	33.1%

upper tercile. middle tercile. lower tercile.

★Better than expected mortality rate, ▼Worse than expected mortality rate.

Table G–8: HOSPITAL CODING PRACTICES OF DATA ELEMENTS IN RISK–ADJUSTMENT MODEL (cont.)

	Percent of Hospital CABG Cases Coded as:								
	COPD	#Co Morbids	# Prior Ops	MI	PTCA	Angina	NYHA	NYHA	CCS
	Yes	3+	3+	0–7 days	Yes	None	III	III or IV	III
AVERAGE	13.3%	4.7%	0.6%	19.9%	3.8%	10.0%	17.4%	29.1%	39.8%
HOAG MEMORIAL PRESBYTERIAN ★	12.9%	8.1%	0.4%	19.2%	7.1%	0.0%	36.7%	56.9%	45.8%
JOHN MUIR MEDICAL CENTER ▼	4.7%	1.6%	0.0%	21.9%	7.8%	12.5%	3.1%	9.4%	18.0%
KAISER FOUNDATION HOSP —GEARY (S.F.)	5.9%	2.5%	0.1%	15.4%	1.7%	15.6%	33.0%	44.8%	74.5%
KAISER FOUNDATION HOSP—SUNSET (L.A.)	10.1%	1.7%	0.3%	20.5%	0.3%	3.1%	6.4%	11.2%	29.2%
KAWEAH DELTA DISTRICT HOSPITAL	20.3%	5.2%	0.2%	16.5%	1.2%	3.9%	12.3%	23.1%	31.0%
LANCASTER COMMUNITY HOSPITAL	8.7%	8.7%	0.0%	26.1%	0.0%	0.0%	4.3%	8.7%	4.3%
LITTLE COMPANY OF MARY HOSPITAL	8.8%	1.3%	1.3%	18.8%	23.8%	20.6%	0.6%	2.5%	8.8%
LONG BEACH MEMORIAL MEDICAL CENTER	14.8%	5.8%	0.5%	21.4%	4.0%	9.5%	47.9%	62.7%	48.7%
LOS ANGELES CO USC MEDICAL CENTER	8.2%	3.4%	0.0%	17.1%	1.4%	17.1%	15.1%	24.0%	61.6%
MARIN GENERAL HOSPITAL	10.6%	4.3%	2.1%	25.5%	5.3%	8.5%	9.6%	10.6%	46.8%
MEDICAL CENTER AT THE UCSF	9.2%	1.4%	0.7%	17.0%	4.3%	1.4%	12.8%	22.0%	52.5%
MEMORIAL HOSPITAL MODESTO	0.0%	0.5%	0.9%	15.8%	5.5%	0.0%	12.2%	48.4%	12.9%
MERCY GENERAL HOSPITAL	9.7%	1.8%	0.0%	25.6%	1.2%	11.4%	4.4%	7.1%	30.4%
MERCY MEDICAL CENTER–REDDING	9.8%	8.8%	0.0%	28.1%	5.3%	0.0%	33.3%	90.4%	32.5%
MERCY SAN JUAN HOSPITAL ▼	11.3%	3.9%	0.0%	34.1%	3.4%	23.0%	3.2%	8.6%	27.9%
METHODIST HOSPITAL OF SOUTHERN CAL	2.3%	2.3%	0.0%	15.2%	4.9%	55.1%	22.7%	37.6%	25.5%
MILLS–PENINSULA MEDICAL CENTER	2.2%	2.2%	0.9%	22.9%	5.6%	18.3%	23.5%	44.3%	42.7%
MT DIABLO MEDICAL CENTER	7.7%	4.8%	0.9%	29.8%	4.6%	0.0%	8.6%	15.5%	30.5%
NORTHRIDGE HOSPITAL MEDICAL CENTER	6.3%	2.7%	0.0%	21.3%	5.6%	23.9%	56.8%	80.7%	57.1%

upper tercile. middle tercile. lower tercile.

★Better than expected mortality rate, ▼Worse than expected mortality rate.

Table G–8: HOSPITAL CODING PRACTICES OF DATA ELEMENTS IN RISK–ADJUSTMENT MODEL (cont.)

	Percent of Hospital CABG Cases Coded as:								
	COPD	#Co Morbids	# Prior Ops	MI	PTCA	Angina	NYHA	NYHA	CCS
	Yes	3+	3+	0–7 days	Yes	None	III	III or IV	III
AVERAGE	13.3%	4.7%	0.6%	19.9%	3.8%	10.0%	17.4%	29.1%	39.8%
PALOMAR MEDICAL CENTER	14.3%	6.0%	0.0%	27.8%	4.0%	10.6%	18.3%	43.3%	30.4%
POMONA VALLEY HOSPITAL MEDICAL CENTER	17.5%	2.5%	1.3%	32.6%	5.7%	25.8%	5.7%	12.7%	55.8%
PRESBYTERIAN INTERCOMMUNITY HOSPITAL ▼	15.4%	2.6%	0.0%	26.5%	7.7%	4.3%	3.6%	77.8%	41.0%
PROVIDENCE HOLY CROSS MEDICAL CENTER	6.1%	0.9%	0.0%	28.1%	0.0%	0.0%	6.1%	49.1%	26.3%
PROVIDENCE SAINT JOSEPH MEDICAL CENTER	7.8%	3.4%	0.4%	14.2%	1.7%	0.0%	4.7%	5.2%	47.4%
REDDING MEDICAL CENTER	21.1%	1.6%	0.0%	17.0%	4.2%	13.8%	0.7%	2.6%	15.5%
RIVERSIDE COMMUNITY HOSPITAL	25.6%	7.0%	1.2%	39.5%	3.5%	9.3%	26.7%	68.6%	94.2%
SADDLEBACK MEMORIAL MEDICAL CENTER	25.1%	14.3%	0.0%	35.4%	3.4%	5.1%	53.7%	82.9%	55.4%
SALINAS VALLEY MEMORIAL HOSPITAL	3.0%	4.4%	0.7%	25.2%	4.4%	0.0%	8.9%	13.3%	21.5%
SAN ANTONIO COMMUNITY HOSPITAL	35.5%	6.5%	0.0%	34.7%	3.2%	3.2%	46.8%	100.0%	46.8%
SANTA BARBARA COTTAGE HOSPITAL	4.9%	1.1%	1.1%	13.5%	3.0%	0.0%	47.6%	83.1%	47.6%
SANTA MONICA—UCLA MEDICAL CENTER	2.2%	0.0%	2.2%	26.7%	2.2%	8.9%	8.9%	11.1%	24.4%
SCRIPPS MEMORIAL HOSPITAL—LA JOLLA	16.3%	6.5%	0.1%	23.3%	6.8%	5.6%	3.0%	9.5%	26.0%
SEQUOIA HOSPITAL	18.6%	11.8%	5.4%	8.7%	1.4%	8.1%	21.1%	59.8%	25.9%
SETON MEDICAL CENTER	10.3%	5.4%	0.8%	11.1%	1.4%	12.5%	0.4%	0.7%	43.2%
SHARP CHULA VISTA MEDICAL CENTER	27.7%	15.8%	0.6%	21.3%	4.9%	3.2%	18.5%	25.2%	52.5%
SHARP GROSSMONT HOSPITAL	12.0%	3.8%	0.8%	28.6%	3.0%	7.5%	23.3%	25.6%	69.9%
SHARP MEMORIAL HOSPITAL	8.2%	3.6%	1.0%	21.4%	1.6%	18.1%	9.9%	10.9%	57.9%
ST. BERNARDINE MEDICAL CENTER	29.6%	6.4%	0.7%	28.6%	1.2%	7.9%	31.4%	86.7%	55.8%

upper tercile. middle tercile. lower tercile.

★Better than expected mortality rate, ▼Worse than expected mortality rate.

Table G–8: HOSPITAL CODING PRACTICES OF DATA ELEMENTS IN RISK–ADJUSTMENT MODEL (cont.)

	Percent of Hospital CABG Cases Coded as:								
	COPD	#Co Morbids	# Prior Ops	MI	PTCA	Angina	NYHA	NYHA	CCS
	Yes	3+	3+	0–7 days	Yes	None	III	III or IV	III
AVERAGE	13.3%	4.7%	0.6%	19.9%	3.8%	10.0%	17.4%	29.1%	39.8%
ST. FRANCIS MEDICAL CENTER	14.5%	4.8%	1.6%	24.2%	0.0%	9.7%	54.8%	85.5%	51.6%
ST. HELENA HOSPITAL & HEALTH CENTER	19.1%	7.4%	0.2%	16.7%	8.4%	0.0%	13.4%	18.4%	30.8%
ST. JOHN'S HOSPITAL AND HEALTH CENTER	7.0%	0.8%	0.4%	20.3%	5.5%	20.3%	41.0%	57.0%	95.7%
ST. JOHN'S REGIONAL MEDICAL CENTER	5.6%	4.4%	1.1%	15.6%	10.0%	0.0%	5.6%	8.9%	23.3%
ST. JOSEPH HOSPITAL—ORANGE	12.6%	5.5%	0.7%	14.7%	3.4%	22.2%	17.1%	32.8%	31.7%
ST. JOSEPH'S MEDICAL CENTER OF STOCKTON	19.5%	4.8%	1.5%	21.8%	3.4%	12.3%	19.3%	22.5%	34.1%
ST. JUDE MEDICAL CENTER	12.2%	3.4%	2.0%	18.0%	5.9%	13.2%	65.4%	83.9%	67.8%
ST. MARY MEDICAL CENTER—LONG BEACH	21.8%	9.2%	0.0%	23.0%	1.1%	0.0%	31.0%	86.2%	29.9%
ST. VINCENT MEDICAL CENTER	14.9%	6.8%	1.4%	6.8%	1.4%	0.0%	13.5%	17.6%	14.9%
STANFORD UNIVERSITY HOSPITAL	6.3%	2.6%	0.0%	10.8%	21.6%	12.6%	19.7%	28.6%	51.3%
SUMMIT MEDICAL CENTER ★	18.2%	7.4%	0.0%	12.9%	4.9%	6.8%	18.8%	25.2%	23.4%
SUTTER MEMORIAL HOSPITAL ★	16.6%	6.6%	0.9%	24.7%	2.5%	7.4%	2.8%	10.6%	19.0%
THE HEART HOSPITAL, INC.	.8%	7.5%	0.0%	9.0%	3.0%	0.0%	11.3%	15.8%	27.1%
TORRANCE MEMORIAL MEDICAL CENTER	9.5%	5.7%	0.7%	3.2%	8.7%	10.0%	24.7%	46.6%	57.9%
TRI–CITY MEDICAL CENTER	9.0%	3.9%	0.9%	19.3%	1.6%	21.8%	45.5%	50.8%	53.1%
UCLA MEDICAL CENTER	5.8%	2.6%	0.0%	18.8%	0.0%	13.6%	22.0%	39.8%	25.1%
UCSD/SAN DIEGO—UNIVERSITY MEDICAL CENTER	11.0%	9.9%	0.5%	12.0%	7.3%	4.2%	32.5%	63.4%	37.2%
UCSF/MT ZION	0.0%	2.3%	0.0%	18.2%	.8%	38.6%	47.7%	61.4%	40.9%
UNIVERSITY OF CALIFORNIA DAVIS MED CENTER	10.8%	1.4%	4.1%	12.2%	4.1%	0.0%	17.6%	18.9%	64.9%

upper tercile. middle tercile. lower tercile.

★Better than expected mortality rate, ▼Worse than expected mortality rate.

Table G–8: HOSPITAL CODING PRACTICES OF DATA ELEMENTS IN RISK–ADJUSTMENT MODEL (cont.)

	Percent of Hospital CABG Cases Coded as:								
	COPD	#Co Morbids	# Prior Ops	MI	PTCA	Angina	NYHA	NYHA	CCS
	Yes	3+	3+	0–7 days	Yes	None	III	III or IV	III
AVERAGE	13.3%	4.7%	0.6%	19.9%	3.8%	10.0%	17.4%	29.1%	39.8%
UNIVERSITY OF CALIFORNIA IRVINE MED CENTER	16.0%	8.5%	2.1%	19.1%	0.0%	17.0%	54.3%	69.1%	98.9%
USC UNIVERSITY HOSPITAL	6.3%	2.8%	0.0%	11.8%	0.0%	28.5%	36.1%	43.8%	89.6%
WASHINGTON HOSPITAL—FREMONT	19.2%	11.4%	0.6%	22.8%	11.1%	13.8%	23.7%	35.3%	36.5%

upper tercile. middle tercile. lower tercile.

★Better than expected mortality rate, ▼Worse than expected mortality rate.

Table G–8: HOSPITAL CODING PRACTICES OF DATA ELEMENTS IN RISK–ADJUSTMENT MODEL (cont.)

	Percent of Hospital CABG Cases Coded as:							
	CCS	Acuity	LM Stenosis	CAD	Mitral Insufficiency	Age	Creatinine	EF
	III or IV	Emergent	>70%	Triple+	Moderate or Severe	≥70	≥2	<30
AVERAGE	76.4%	6.4%	9.6%	74.2%	1.8%	42.1%	4.8%	4.9%
ALTA BATES MEDICAL CENTER	84.8%	12.0%	12.0%	72.1%	0.7%	45.3%	2.2%	3.6%
ALVARADO HOSPITAL MEDICAL CENTER	63.4%	7.7%	11.7%	66.4%	1.7%	47.7%	6.4%	4.7%
ANAHEIM MEMORIAL MEDICAL CENTER	50.8%	5.4%	14.6%	78.5%	2.3%	40.0%	3.8%	5.4%
CALIFORNIA PACIFIC MEDICAL CTR—PACIFIC CAMPUS	55.1%	7.4%	9.7%	80.7%	4.5%	44.3%	9.7%	6.3%
CEDARS–SINAI MEDICAL CENTER	67.5%	4.7%	9.9%	60.5%	0.0%	52.2%	5.8%	4.6%
CITRUS VALLEY MEDICAL CENTER—IC CAMPUS	79.1%	6.5%	5.3%	81.4%	0.5%	41.9%	5.6%	2.6%
COMMUNITY MEMORIAL HOSP—SAN BUENAVENTURA	99.0%	1.5%	8.9%	64.4%	0.5%	52.0%	2.5%	2.5%
DAMERON HOSPITAL	84.1%	4.7%	9.3%	64.5%	4.7%	37.4%	8.4%	7.5%
DANIEL FREEMAN MEMORIAL HOSPITAL	100.0%	8.1%	9.2%	86.1%	2.9%	49.1%	5.8%	4.6%
DESERT REGIONAL MEDICAL CENTER	14.8%	4.9%	9.8%	59.0%	0.8%	39.3%	1.6%	4.1%
DOCTORS MEDICAL CENTER—MODESTO	92.7%	2.0%	8.2%	81.2%	1.6%	37.7%	1.3%	5.1%
DOCTORS MEDICAL CENTER—SAN PABLO	97.6%	4.1%	21.3%	79.9%	3.0%	43.2%	5.3%	6.5%
DOMINICAN SANTA CRUZ HOSPITAL—SOQUEL	68.0%	9.9%	20.2%	60.7%	2.9%	48.2%	1.1%	2.9%
DOWNEY COMMUNITY HOSPITAL ▼	47.3%	5.4%	11.3%	67.8%	0.0%	55.2%	4.2%	3.8%
EL CAMINO HOSPITAL	59.6%	3.8%	19.2%	76.9%	3.8%	46.2%	7.7%	0.0%
ENCINO TARZANA REGIONAL MEDICAL CENTER	71.0%	18.6%	0.0%	99.3%	5.5%	57.2%	4.8%	9.0%
GLENDALE ADVENTIST MEDICAL CENTER	84.2%	5.4%	11.3%	77.8%	1.5%	47.8%	4.4%	2.8%
GLENDALE MEMORIAL HOSPITAL & HEALTH CTR	92.4%	7.2%	2.7%	75.8%	0.0%	48.9%	5.4%	8.1%
GRANADA HILLS COMMUNITY HOSPITAL	88.7%	2.1%	4.9%	66.2%	1.4%	41.5%	4.9%	7.0%

upper tercile. middle tercile. lower tercile.

★Better than expected mortality rate, ▼Worse than expected mortality rate.

Table G–8: HOSPITAL CODING PRACTICES OF DATA ELEMENTS IN RISK–ADJUSTMENT MODEL (cont.)

	Percent of Hospital CABG Cases Coded as:							
	CCS	Acuity	LM Stenosis	CAD	Mitral Insufficiency	Age	Creatinine	EF
	III or IV	Emergent	>70%	Triple+	Moderate or Severe	≥70	≥2	<30
AVERAGE	76.4%	6.4%	9.6%	74.2%	1.8%	42.1%	4.8%	4.9%
HOAG MEMORIAL PRESBYTERIAN ★	72.4%	19.6%	10.3%	84.3%	2.6%	41.7%	4.4%	5.0%
JOHN MUIR MEDICAL CENTER ▼	68.8%	15.6%	10.2%	63.3%	7.0%	43.0%	5.5%	6.3%
KAISER FOUNDATION HOSPITAL—GEARY (S.F.)	79.8%	3.1%	9.4%	84.8%	0.5%	32.9%	5.1%	3.6%
KAISER FOUNDATION HOSPITAL—SUNSET (L.A.)	96.7%	1.5%	6.2%	76.0%	0.3%	31.9%	4.0%	3.0%
KAWEAH DELTA DISTRICT HOSPITAL	67.1%	3.4%	11.4%	81.3%	1.1%	41.5%	5.9%	4.3%
LANCASTER COMMUNITY HOSPITAL	43.5%	8.7%	21.7%	43.5%	13.0%	47.8%	4.3%	0.0%
LITTLE COMPANY OF MARY HOSPITAL	100.0%	21.3%	0.0%	81.3%	3.8%	41.3%	8.1%	4.4%
LONG BEACH MEMORIAL MEDICAL CENTER	63.2%	7.9%	0.0%	73.0%	1.3%	45.2%	3.2%	5.8%
LOS ANGELES CO USC MEDICAL CENTER	82.2%	8.2%	6.8%	84.2%	0.7%	13.7%	4.8%	7.5%
MARIN GENERAL HOSPITAL	72.3%	10.6%	17.0%	62.8%	2.1%	41.5%	8.5%	8.5%
MEDICAL CENTER AT THE UCSF	85.1%		20.6%	83.0%	0.7%	34.8%	8.5%	8.5%
MEMORIAL HOSPITAL MODESTO	67.8%	3.3%	9.5%	63.8%	3.1%	34.5%	3.6%	4.9%
MERCY GENERAL HOSPITAL	73.6%	2.8%	8.2%	69.2%	0.6%	39.1%	3.8%	2.5%
MERCY MEDICAL CENTER—REDDING	89.5%	8.8%	2.6%	74.6%	0.9%	40.4%	2.6%	2.6%
MERCY SAN JUAN HOSPITAL ▼	68.1%	5.1%	12.7%	78.2%	0.0%	39.5%	2.9%	2.7%
METHODIST HOSPITAL OF SOUTHERN CAL	40.0%	14.5%	4.2%	82.7%	2.8%	54.0%	2.8%	3.0%
MILLS–PENINSULA MEDICAL CENTER	77.4%	5.3%	7.1%	76.8%	0.6%	40.2%	2.8%	6.5%
MT DIABLO MEDICAL CENTER	64.9%	12.7%	14.3%	74.0%	2.3%	40.3%	16.9%	4.5%
NORTHRIDGE HOSPITAL MEDICAL CENTER	80.7%	9.0%	7.0%	75.7%	0.0%	52.5%	3.3%	7.0%

upper tercile. middle tercile. lower tercile.

★Better than expected mortality rate, ▼Worse than expected mortality rate.

Table G–8: HOSPITAL CODING PRACTICES OF DATA ELEMENTS IN RISK–ADJUSTMENT MODEL (cont.)

	Percent of Hospital CABG Cases Coded as:							
	CCS	Acuity	LM Stenosis	CAD	Mitral Insufficiency	Age	Creatinine	EF
	III or IV	Emergent	>70%	Triple+	Moderate or Severe	≥70	≥2	<30
AVERAGE	76.4%	6.4%	9.6%	74.2%	1.8%	42.1%	4.8%	4.9%
PALOMAR MEDICAL CENTER	70.2%	3.4%	0.0%	71.1%	16.6%	53.3%	4.9%	2.9%
POMONA VALLEY HOSPITAL MEDICAL CENTER	95.3%	8.9%	11.0%	72.9%	0.2%	40.0%	3.2%	9.5%
PRESBYTERIAN INTERCOMMUNITY HOSPITAL ▼	75.2%	3.4%	15.4%	66.7%	0.0%	40.2%	4.3%	0.9%
PROVIDENCE HOLY CROSS MEDICAL CENTER	99.1%	15.8%	10.5%	82.5%	0.0%	36.0%	0.9%	6.1%
PROVIDENCE SAINT JOSEPH MEDICAL CENTER	62.9%	11.2%	12.9%	77.6%	0.0%	50.4%	5.2%	6.5%
REDDING MEDICAL CENTER	72.1%	5.2%	0.0%	72.5%	1.2%	43.9%	1.7%	1.8%
RIVERSIDE COMMUNITY HOSPITAL	100.0%	16.3%	15.1%	70.9%	2.3%	43.0%	9.3%	11.6%
SADDLEBACK MEMORIAL MEDICAL CENTER	84.0%	5.7%	17.7%	68.6%	0.6%	56.6%	4.6%	1.1%
SALINAS VALLEY MEMORIAL HOSPITAL	63.7%	12.6%	11.1%	68.1%	6.7%	45.9%	14.1%	8.1%
SAN ANTONIO COMMUNITY HOSPITAL	100.0%	15.3%	12.1%	75.0%	1.6%	33.1%	3.2%	7.3%
SANTA BARBARA COTTAGE HOSPITAL	84.3%	9.7%	15.0%	66.7%	1.1%	44.2%	1.5%	2.6%
SANTA MONICA—UCLA MEDICAL CENTER	77.8%	11.1%	15.6%	88.9%	0.0%	55.6%	4.4%	6.7%
SCRIPPS MEMORIAL HOSPITAL – LA JOLLA	67.7%	4.2%	20.9%	65.6%	3.3%	45.8%	4.5%	4.7%
SEQUOIA HOSPITAL	73.1%	5.4%	11.6%	72.7%	3.1%	43.1%	6.0%	11.2%
SETON MEDICAL CENTER	76.9%	3.4%	7.6%	75.7%	6.8%	38.8%	5.0%	6.7%
SHARP CHULA VISTA MEDICAL CENTER	88.5%	10.2%	11.9%	75.1%	2.6%	45.2%	8.5%	4.3%
SHARP GROSSMONT HOSPITAL	85.0%	4.5%	11.3%	62.4%	0.0%	39.8%	4.5%	4.5%
SHARP MEMORIAL HOSPITAL	77.6%	3.9%	12.8%	63.8%	0.0%	47.7%	4.6%	5.6%
ST. BERNARDINE MEDICAL CENTER	81.7%	11.6%	0.0%	83.2%	2.0%	46.7%	4.7%	8.9%

upper tercile. middle tercile. lower tercile.

★Better than expected mortality rate, ▼Worse than expected mortality rate.

Table G–8: HOSPITAL CODING PRACTICES OF DATA ELEMENTS IN RISK–ADJUSTMENT MODEL (cont.)

	Percent of Hospital CABG Cases Coded as:							
	CCS	Acuity	LM Stenosis	CAD	Mitral Insufficiency	Age	Creatinine	EF
	III or IV	Emergent	>70%	Triple+	Moderate or Severe	≥70	≥2	<30
AVERAGE	76.4%	6.4%	9.6%	74.2%	1.8%	42.1%	4.8%	4.9%
ST. FRANCIS MEDICAL CENTER	87.1%	6.5%	14.5%	85.5%	1.6%	45.2%	14.5%	21.0%
ST. HELENA HOSPITAL AND HEALTH CENTER	45.6%	9.3%	10.0%	86.4%	1.0%	50.6%	3.1%	2.6%
ST. JOHN'S HOSPITAL AND HEALTH CENTER	95.7%	6.6%	13.3%	81.3%	0.8%	54.7%	3.1%	3.1%
ST. JOHN'S REGIONAL MEDICAL CENTER	85.6%	5.6%	7.8%	55.6%	3.3%	52.2%	4.4%	7.8%
ST. JOSEPH HOSPITAL—ORANGE	52.9%	12.3%	10.2%	82.6%	0.0%	36.5%	2.0%	2.0%
ST. JOSEPH'S MEDICAL CENTER OF STOCKTON	54.3%	8.2%	14.8%	66.6%	0.7%	40.5%	7.9%	8.4%
ST. JUDE MEDICAL CENTER	86.8%	8.8%	3.9%	77.6%	0.5%	36.6%	1.5%	2.9%
ST. MARY MEDICAL CENTER—LONG BEACH	85.1%	18.4%	9.2%	80.5%	13.8%	50.6%	8.0%	13.8%
ST. VINCENT MEDICAL CENTER	18.9%	6.8%	6.8%	77.0%	8.1%	55.4%	10.8%	8.1%
STANFORD UNIVERSITY HOSPITAL	72.5%	1.9%	11.9%	69.9%	1.1%	46.8%	4.1%	5.6%
SUMMIT MEDICAL CENTER ★	93.2%	5.8%	22.5%	83.4%	1.5%	43.1%	7.1%	7.1%
SUTTER MEMORIAL HOSPITAL ★	72.3%	5.3%	11.0%	74.8%	0.8%	42.1%	5.5%	5.3%
THE HEART HOSPITAL, INC.	67.7%	1.5%	9.0%	57.9%	9.0%	63.2%	3.0%	3.8%
TORRANCE MEMORIAL MEDICAL CENTER	89.3%	18.5%	8.0%	73.1%	3.2%	38.2%	5.0%	2.7%
TRI-CITY MEDICAL CENTER	73.1%	6.5%	9.7%	65.4%	0.0%	52.0%	3.7%	2.8%
UCLA MEDICAL CENTER	65.4%	9.4%	9.9%	76.4%	8.4%	35.6%	8.4%	10.5%
UCSD/SAN DIEGO—UNIVERSITY MEDICAL CTR	84.3%	7.3%	22.5%	87.4%	2.6%	33.5%	12.0%	8.9%
UCSF/MT ZION	61.4%	4.5%	29.5%	70.5%	2.3%	50.0%	2.3%	11.4%
UNIVERSITY OF CALIFORNIA DAVIS MEDICAL CTR	94.6%	12.2%	9.5%	73.0%	1.4%	27.0%	9.5%	4.1%

upper tercile. middle tercile. lower tercile.

★Better than expected mortality rate, ▼Worse than expected mortality rate.

Table G–8: HOSPITAL CODING PRACTICES OF DATA ELEMENTS IN RISK–ADJUSTMENT MODEL (cont.)

	Percent of Hospital CABG Cases Coded as:							
	CCS	Acuity	LM Stenosis	CAD	Mitral Insufficiency	Age	Creatinine	EF
	III or IV	Emergent	>70%	Triple+	Moderate or Severe	≥70	≥2	<30
AVERAGE	76.4%	6.4%	9.6%	74.2%	1.8%	42.1%	4.8%	4.9%
UNIVERSITY OF CALIFORNIA IRVINE MEDICAL CTR	98.9%	2.1%	9.6%	79.8%	0.0%	28.7%	5.3%	10.6%
USC UNIVERSITY HOSPITAL	91.0%	2.8%	11.1%	69.4%	2.1%	36.8%	5.6%	8.3%
WASHINGTON HOSPITAL—FREMONT	63.8%	11.4%	14.1%	78.7%	4.2%	44.3%	9.0%	4.5%

upper tercile. middle tercile. lower tercile.

★Better than expected mortality rate, ▼Worse than expected mortality rate.

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